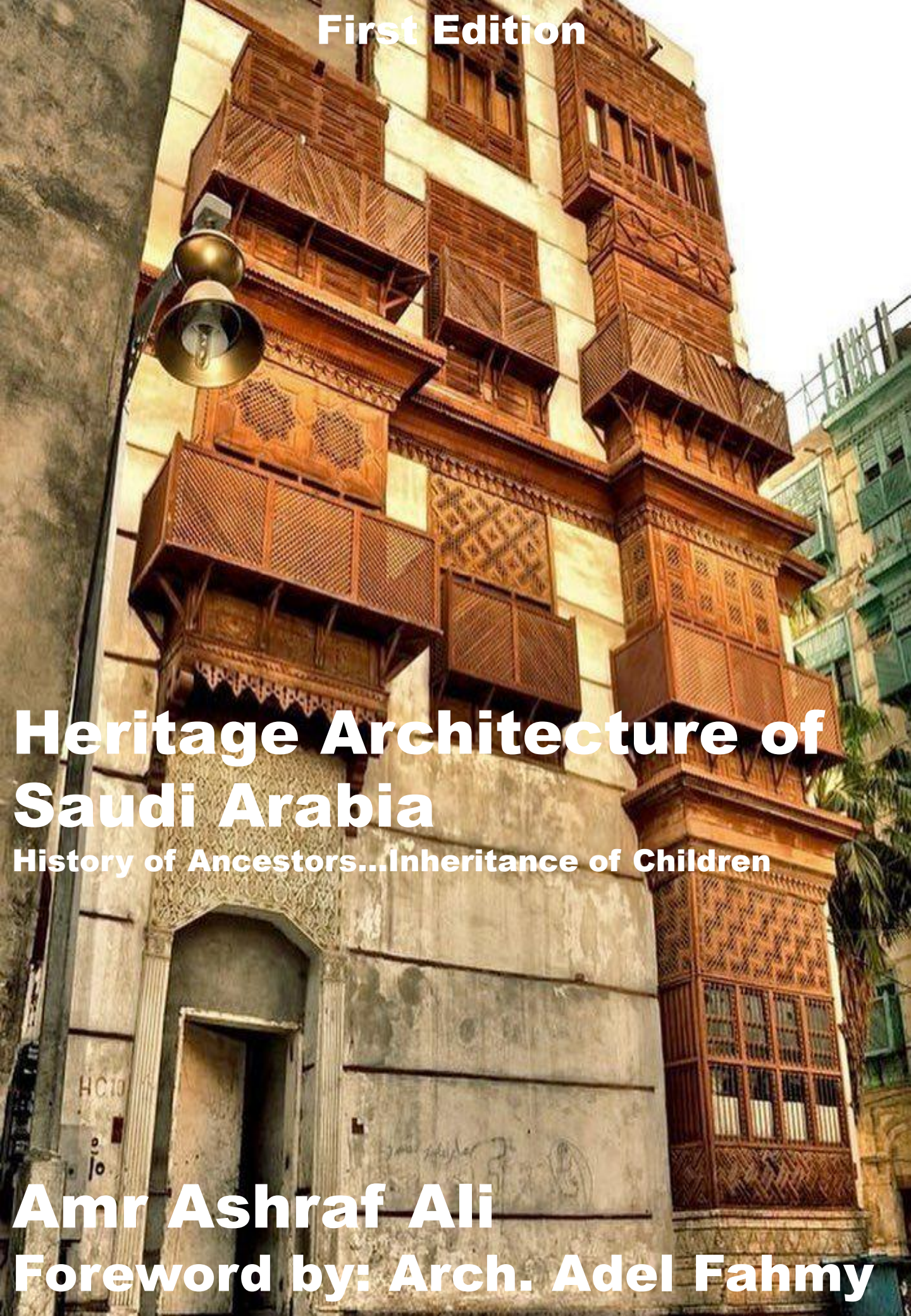
First Edition



Heritage Architecture of Saudi Arabia

History of Ancestors...Inheritance of Children

Amr Ashraf Ali

Foreword by: Arch. Adel Fahmy

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بسم الله الرحمن الرحيم

Content

Foreword

Such a great opportunity to have this manual for historical and traditional Saudi Arabian Architecture, it firstly explains the historical areas, then the way to renovate them to conserve and preserve them for the coming generations.

Architectural heritage is the inheritance of grandparents to children. Some of them leave money to their children, some leave assets, and some leave history and heritage to their children. This type is the most precious thing the old generation can offer to the new generation. Preserving heritage is the most precious thing they can offer.

This book is a powerful opportunity to document the architectural history and heritage of Saudi Arabia, and how to preserve them for future generations. It is a strong step by new youth with open mind who know well how to preserve the past to build the future. Preserving heritage begins with adopting a strong methodological basis in restoring and renovating architectural heritage, and this is what this book explains in detail.

“Soil and soul belong together”

Arch. Adel Fahmy

Acknowledgement

I would like to express my dearest thanks and sincere gratitude to all my friends and family and all who help and stand beside me to make this book came true.

For all people who believed in me one day, for all who stand beside me through thick and thin, thank you from all my heart.

Special thanks and sincere gratitude to my instructor and the one who teach me a lot Arch. Adel Fahmy, without his help and support this book was not about to see the light.

The Author
Amr Ashraf Ali

Introduction

Introduction

Architecture Of Saudi Arabia was not different in the pre-oil era during the early 1930s from what it was across the past centuries. Construction and building activities followed a simple and modest style back then, as there was a lack of specialized architects in the modern sense. Instead, native communities would erect their own structures manually through the efforts of builders using basic means and local materials in what came to be known as “traditional architecture.” Every region in Saudi Arabia was famous for its own brand of architecture that expressed its artistic taste. Building materials used at that time were sourced from the local environment, such as clay, rock, palm fronds, and wood. Similarly, the architectural styles passed on from generation to generation reflected each region's climatic and environmental conditions.

The area for the modern day of Saudi Arabia can be divided by four distinct regions and due to the unique geographical location of Saudi Arabia, the climate varies from region to region, so the style of architecture in each region is different.

The Arabian Peninsula and the territory of the Kingdom of Saudi Arabia are currently known as a corridor for trade caravans in The ancient world and an active urban center with cities that are more than thousands of years old, such as Al-Ahsa and Mecca Najran, Al-A’al, and others, and this is what made the architectural accumulation distinguished by its extreme specificity and identity that is well-established one that refers to it strongly and clearly, the Saudi house is shared from the far north to the farthest The south and from the Gulf to the Red Sea have several characteristics that combine them, such as achieving individuality and privacy completeness, capacity, and multiple rooms and uses, but each house differs from the other according to the

location according to its data, the southern house is made of stone and the northern house is made of mud brick, while the colors and decorations of the house are followed; for the vocabulary of the place that distinguished each region from another.

Specialists in the Kingdom's urban heritage have distinguished between several main urban styles:
The central region is the “Najdi style”, the eastern region is the “Arabian Gulf style”, the western region is the “Red Sea Basin style”, and the southern region is the “Sarah style,” and each style has its own characteristics, decorations and materials used.

Architecture in the Western Region
In the western region, it is a hot-humid climate and located in coastal plain along the Red Sea The structural skeleton of the house is made up of large coral columns and with wood floors and roofs. In ground floor is general sitting room and the more private sitting room is located on the first floor. The sleeping room is generally located on the upper floor and in summer are sleep on the roof so that there is better ventilation in the sea breeze and natural winds.

Architecture in the Central and Northern Region
In the central and northern, it is a desert climate, therefore, the weather is hot and dry and has a great temperature difference between day and night. The typical houses in the Najd region are usually two stories high and built around an open central courtyard. The shape of the courtyard is usually geometric like a rectangle or a square and it works as lungs of the houses to regulate the microclimate and provide a private space for the family to maintain the private life. The houses are built on either side of the narrow streets, providing a shady place for pedestrians. The roof level of the house is used for sleeping in

summer. The main material to built this kind of house is sun-dried mud bricks and mud. The mud is worked as plastering material used to smear interior and exterior walls; it is very suitable for the sandy weather the reason why is because the color is unaffected by the weather. The exterior walls are thick which are about 80–100 cm, thus, it can effectively isolate high temperate and create comfort level to the residents.

Architecture in the Eastern Region

In the eastern region, it is a hot humid region along the Persian Gulf. It has the extreme weather which means in summer months it is hot and dry and has a high rate of humidity temperature day and night.

The traditional house in this region has a courtyard style and the arcade balcony around the house. Due to the harsh climate, the height of the typical house in the eastern region is one to three stories high and the building is very compact, resulting in a narrow passage between the house and the house. The wall of this type of houses is thicker than other types which have better heat resistant and has the effect of insulating. The way to create natural ventilation by installation wind catchers.

Asir region

The Asir region, it is a high mountains province to the southwest side, and it has the Mediterranean climates which characteristics are dry summers and rainy winter.

The Asir houses are commonly built on the high mountains' province due to its geographical location. Climatic conditions promoted the emergence of architectural society. The building normally makes up by one ground and two upper floors which can provide shelter for man and tamed animals. The main sitting room is on the first floor, while the top floor is the kitchen and

bedroom, at the same time the open terrace is also added to the upper floor for wash purpose. In each house there is at least one room used for male reception, which separates from female quarters and family living rooms. The staircase occupies the middle of the house and material of the staircase is mud and use wooden beams to sustained.

Najdi House

Najdi House

The Najdi house is generally made of mud, which is most suitable for desert areas. It works as a heat neutralizer, providing coolness in the summer and heat in the winter. The mud is collected from the edges of the valleys, where the construction teacher “Al-Mu’allem” plans the land and raises the foundations.

The most important sections of the house:

1) Al-Diwaniya:

Also known as “Al-qahwa” or “Al-dikka”, it is a gathering room for men in occasions and visits. It is usually high and decorated with the most beautiful colors. It has windows (dash) and openings to let out smoke (louh) over the fire pit.

2) Al-Laywan:

It is a porch “Riwaq” adjacent to the coffee shop, and it is open to the air for people to sit in and enjoy the atmosphere.

3) Stove “Al-Mawqad”:

It is the kitchen, feeding place and firewood.

4) Dome “Al-Qubba”:

It is the hall where the family gathers.

5) Al-Rawshan:

A separate upper room.

6) Yard “Al-Housh”:

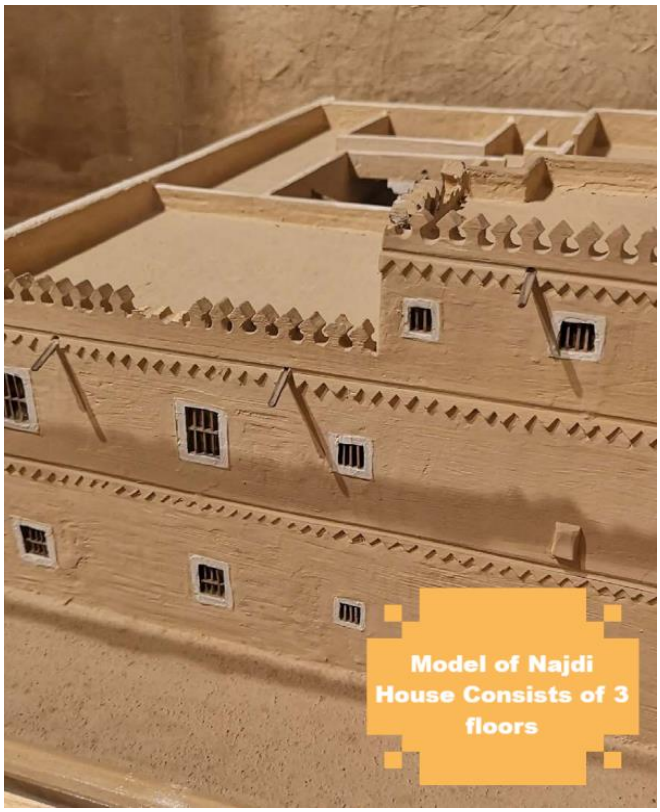
An area containing palm trees or trees and animals such as chickens, sheep, etc…

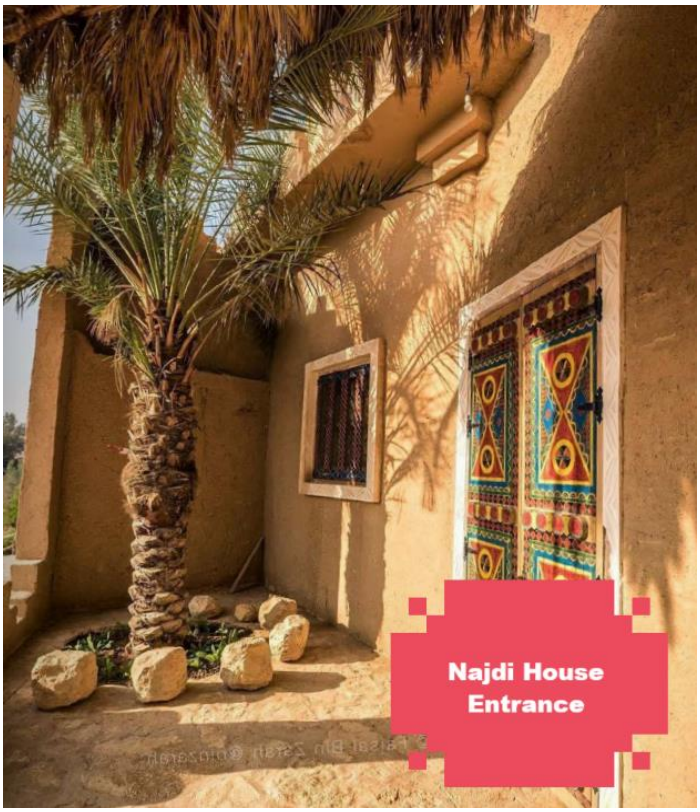
7) Bathroom “Al-Kaneef”:

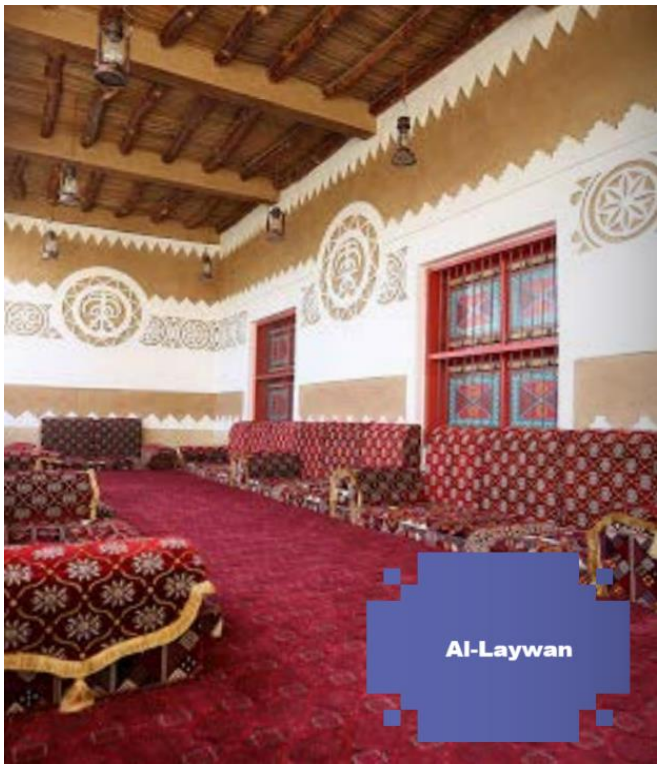
It is a bathroom and located on the outskirts of the house.

Special specifications

The door in the Najdi house is usually made of tamarisk wood and is colored and decorated with Najdi words and colors. The Najdi house is also distinguished by a belt above the roof jacket, “Zaraneeq” of graduated triangles, with its base down, and it is painted with stucco motifs.








Al-Diwaneya


Main entrance door

Hijazi House

Hijazi House

The Hijazi House stems from fixed origins and clear Arab Islamic features. It is a house characterized by light, aesthetic engineering, and Islamic architecture at its finest, and reflects the accumulation of Islamic architectural thought throughout the ages. The primary building material in the Hijazi House consists of stones, and the people of the region call it “Al-Qahout,” which is red in color. It has a yellowish color and is soft to use. It traps moisture and insulates heat. It is also distinguished by its wooden windows “Roshan” that protrude from the body of the building.

The most important sections of the house:

1) Vestibule “Al-Dihliz”:

It is the first thing a visitor finds in the house, and this vestibule takes the form of a room, or a living room furnished with sand that distributes the interior of the house.

2) Al-Majlis:

The largest and best furnished room in the house is located at the front of the house.

3) Al-Suffa:

A small room attached to Al-Majlis and used as a living room.

4) Al-Mu’akhar:

A room for women at the end of the house.

5) Al-Manama:

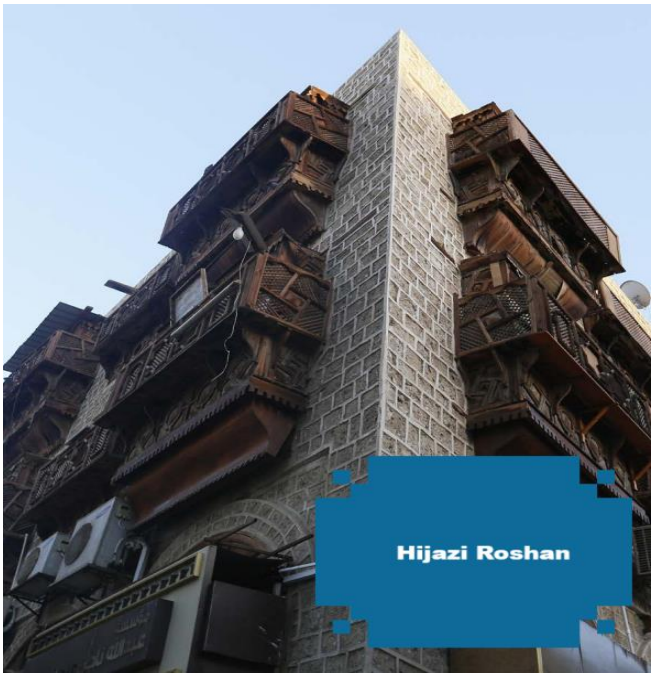
Sleeping rooms of the family on the upper floor.

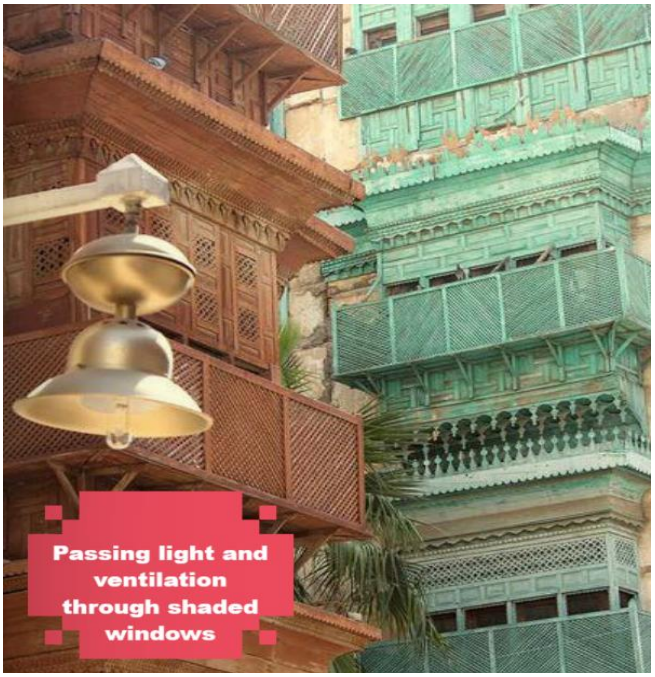
6) Al-Markab:

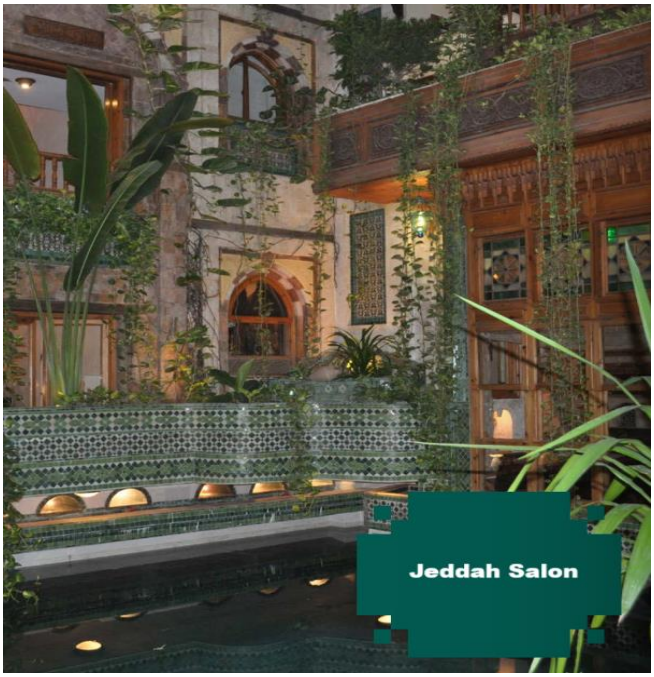
The home kitchen is usually located near the vestibule and living room.

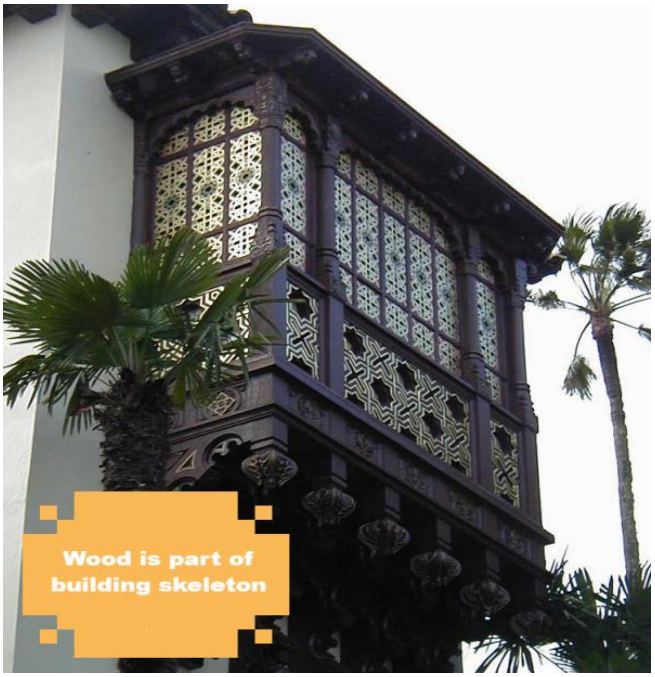
Special specifications

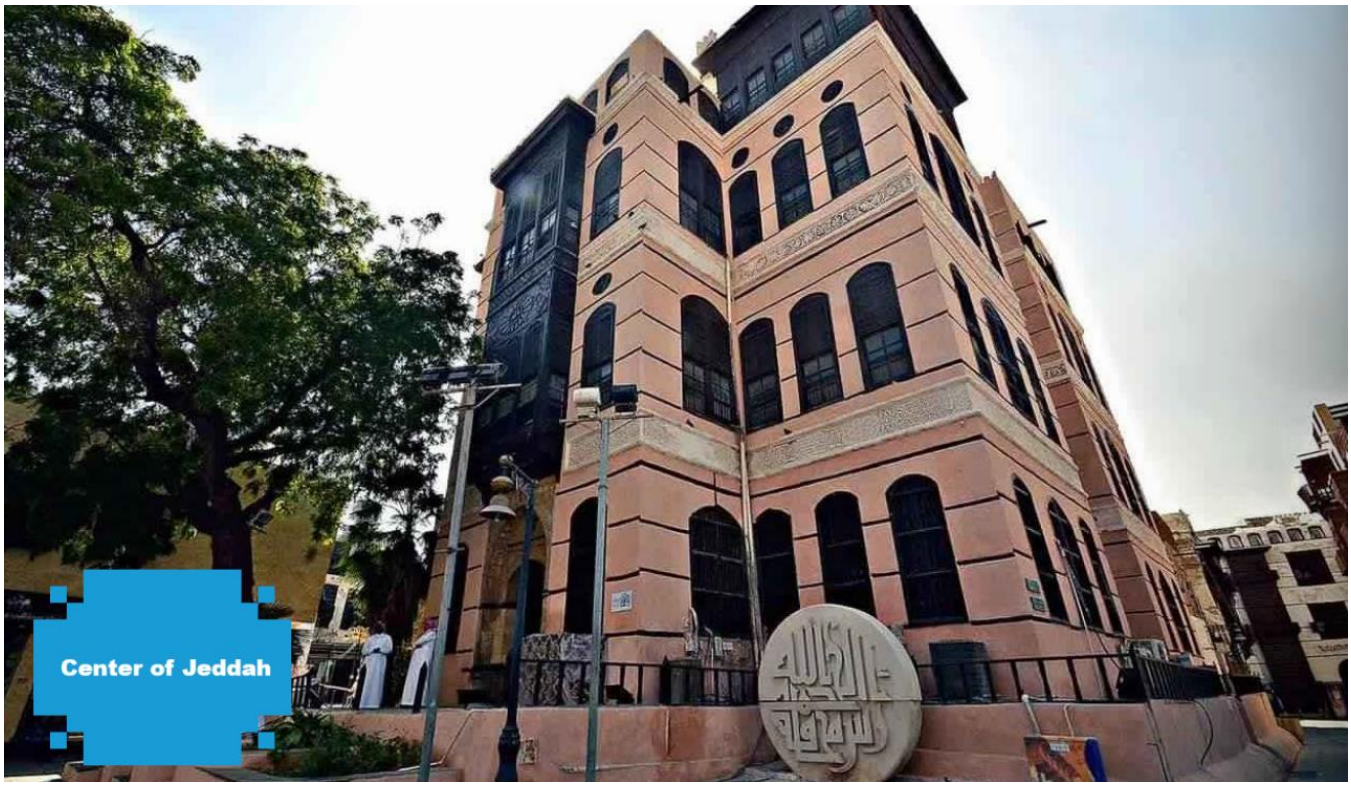
The first feature of the Hijazi house is the “Rawashin”, which add an aesthetic character to the facade of the house and provide privacy for its people. It is also in great harmony with the climate and weather fluctuations, as these windows distribute internal lighting, giving the rooms and halls a warm character by controlling the system of moldings and grilles. Interwoven and at the same time reduces the glare of the sun.










Center of Jeddah


Hijazi Bedroom

Ahsa’i House

Ahsa’i House

The abundance of palm trees in the Al-Ahsa region had a great impact on the Al-Ahsa house, as it benefited from its wood, leaves, and trees inside and outside. The main body of the house is made of clay from the region, along with stucco for framing and decoration. The house is roofed with fronds and trunks “Danshal”, and its ceilings are decorated with lanterns that are lit at night. It has two floors, the first for living and the second for sleeping.

The most important sections of the house:

1) Al-Laywan:

It is an outdoor session in which the family or guests gather on the side of the house. The seat is usually elevated, in the shade and with the air blowing.

2) Al-Muraba’a room:

The main sitting room contains cushions, mattresses, a coffee pot, cups, a water thermos, a coffee grinder, and a heater, in addition to a radio, utensils, and rose water sprinklers.

3) Al-Arous room:

It includes the bride's tablecloth, decorations, and the groom's dinner, and next to it is the (Mother of the Bride's) room, where the mother sleeps next to her daughter on her wedding night.

4) Bedroom:

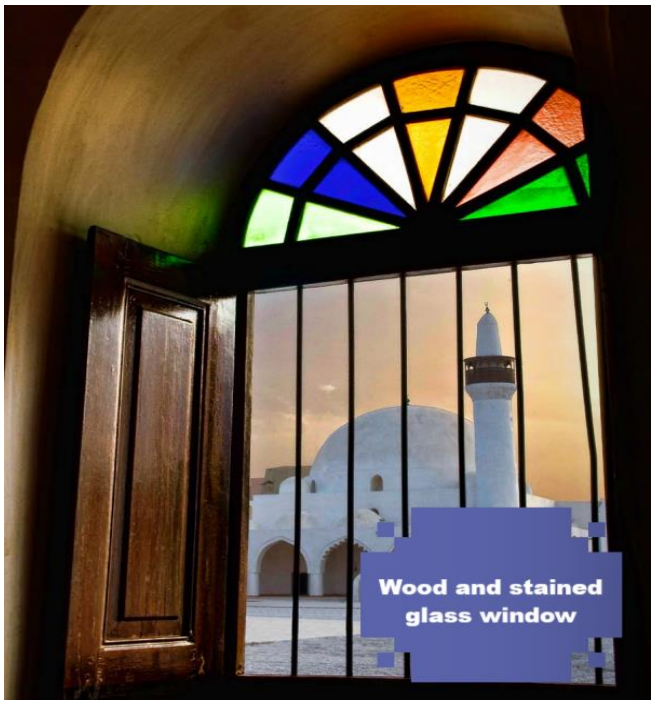
It must be large in the Al-Ahsa home to place toiletries, the large bed, and the children’s rocking bed.

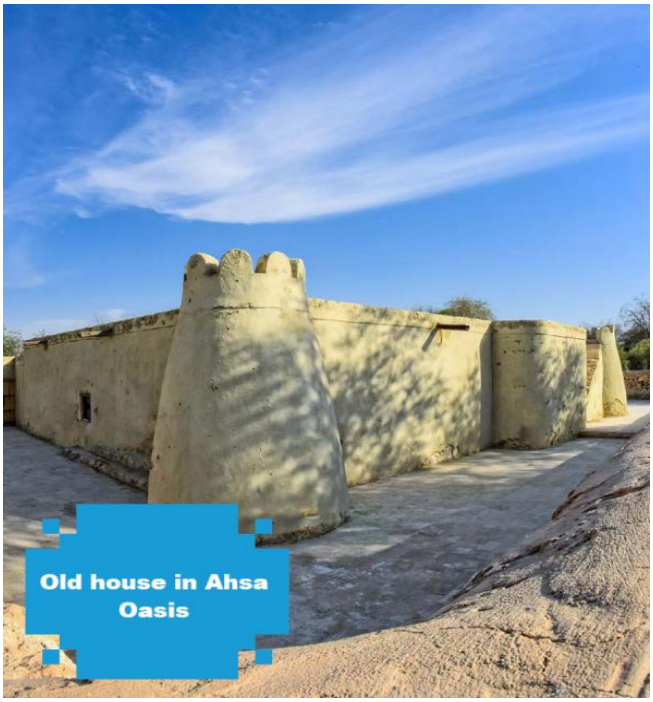
5) Kitchen:

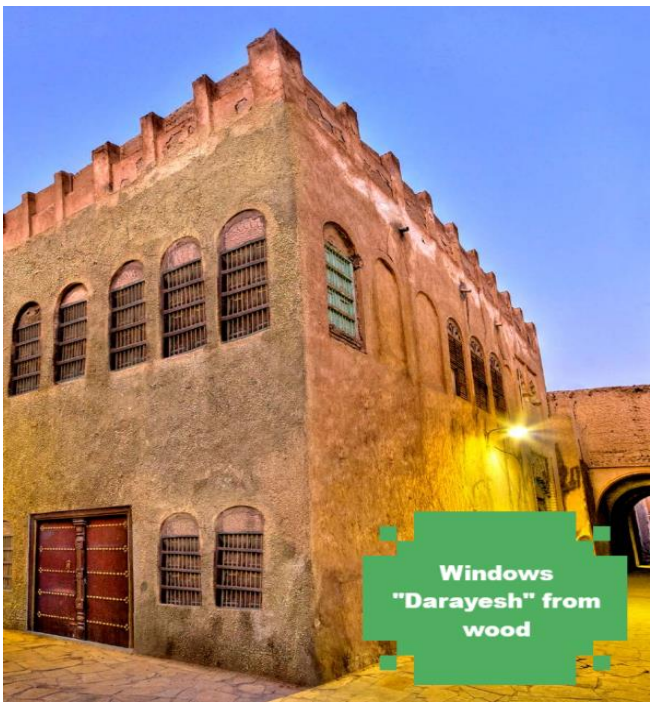
The cooking place includes the “Al-julla” and the “Al-dafur” and various types of pots and plates and anything related to the kitchen, such as spoons, spoons, and the like.

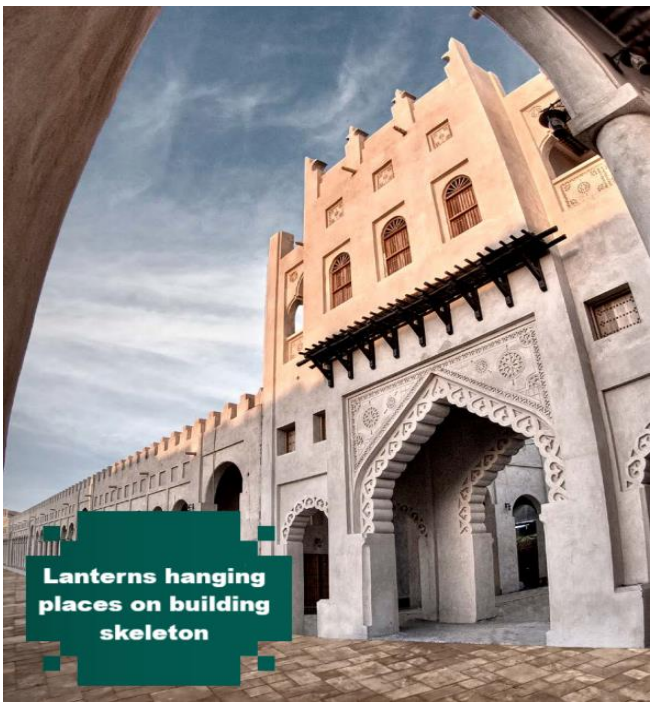
Special specifications

The Al-Ahsa House is distinguished by its special architectural identity accumulated over thousands of years. This is clearly demonstrated by the precision of the measurements used in the arches and columns, the proportion between the windows, and taking into account the air currents in the house. The houses contain “Badjir” wind catcher to bring air currents from the roof into the house.










Distributing windows abundantly to allow airflow to passing through


Interior arches

Haili House

Haili House

The Hail House takes into account the cold temperatures in the north of the Kingdom. You will find most of it has added straw to the mud of the houses to be more insulated and consistent against erosion factors. White stucco is also used to line and decorate the edges of the house, the windows, and the roof covering, which is usually triangular in angle. top and gradually down. The Haili House takes special care of the guests and provides them with the most important rooms of the house.

The most important sections of the house:

1) Al-Laywan:

It is usually open-faced and has three walls next to Al-majlis.

2) Dome “Al-qubba”:

A circular, domed, open area that takes seat in the summer.

3) Al-Maskhan:

It is the family sitting room in the winter, and there is a “Kanun” in it, and it is used by the family on cold days.

4) Dar Al-sha’ib:

It is a room designated for the head of the house out of respect for him and to give him the greatest amount of privacy.

5) Al-maqid:

the place of food cooking and preparation.

6) Dar Al-mahal:

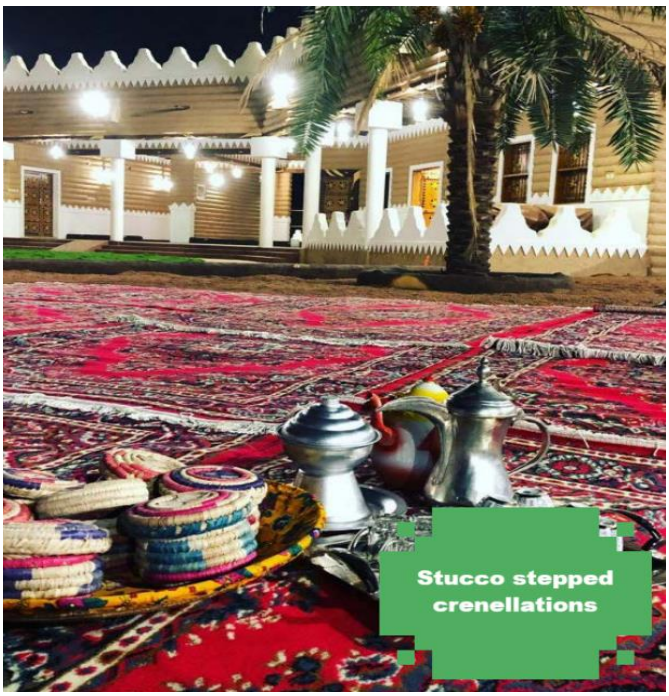
It is the pantry where the family stores their food.

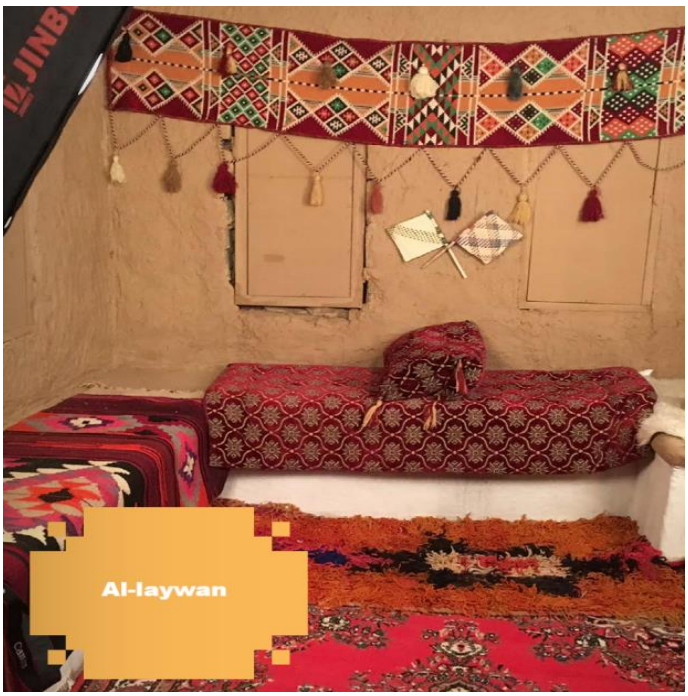
7) Al-aroos room:

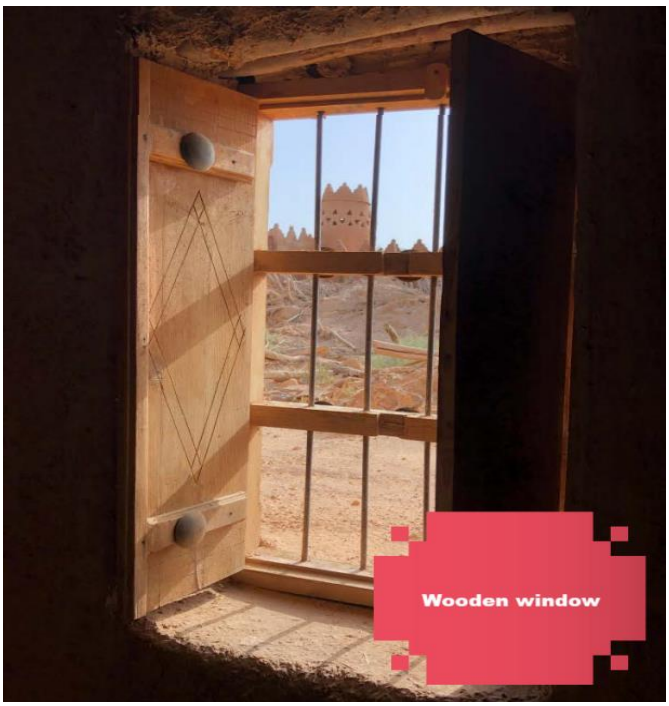
The women's dressing room, where there are clothes, mirrors patterned with peacock feathers, a box, tambourines, and colorful cushions.

Special specifications

The door of the Haili house is called the Al-tala'i, and it is accompanied by "Al-katula" which is a protrusion that is usually above the door to identify who is knocking. It has many sections attached to the house, such as Bayt Al-Iddah, and Al-qusayr, which is a place where they produce milk, it is usually at the bottom of the stairs, also Al-maragha, the place where children play, and Bayt Al-hatab and Al-esha, which is roofed with asib wood.







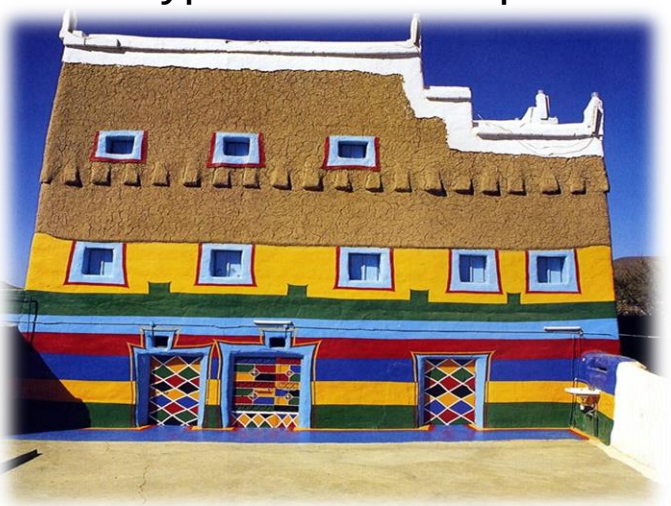

Al-majlis


Old Haili house

Asiri House

Asiri House

The Asiri House is built in three styles. The first is made of pure stone and is stabilized with clay. The second is one in which the clay is intertwined with the stone “Al-Raqf ”,this style is called “Al-Khalab,” in which the clay is placed on layers of “courses,” and its strength may reach five floors. The third type is built with pure clay. It is used in hard places so that the floor is stable, and all styles are distinguished by their bright colors.



The most important sections of the house:

1) Al-majlis:

A room where men gather for occasions and visits, it is usually on the first floor and is decorated with Asiri arts and colored stucco.

2) Al-ruba’a:

It is the house store and is on the ground floor.

3) Al-malhab:

It is the kitchen and is usually on the highest floor of the building so that its smoke does not cause inconvenience to the family and guests.

4) Al-malqat:

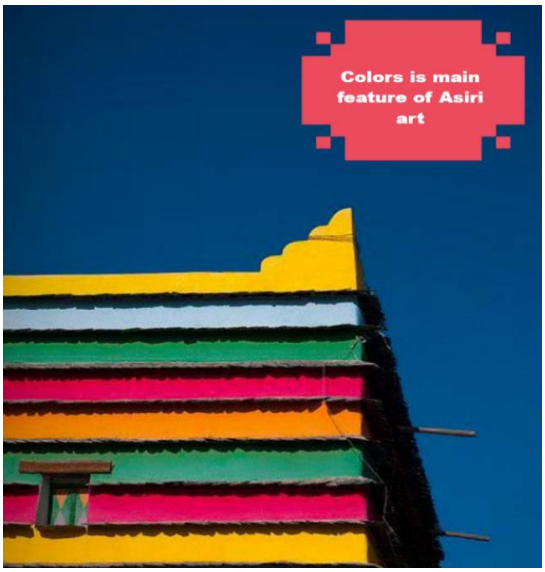
It is the dining room or for sleeping and siesta.

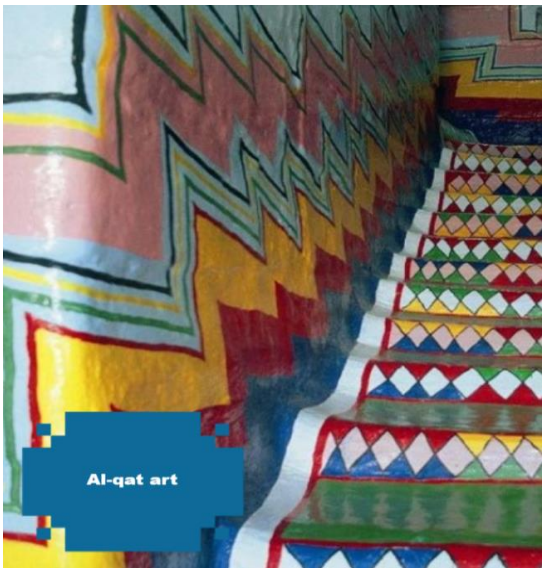
5) Al-mastaba:

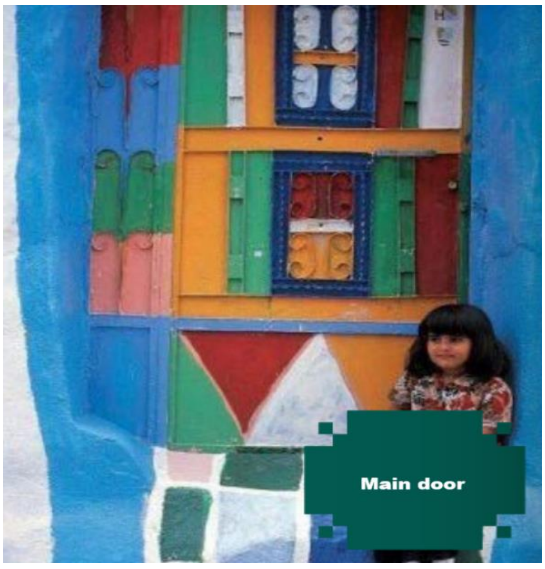
An open upper room where the family sits.

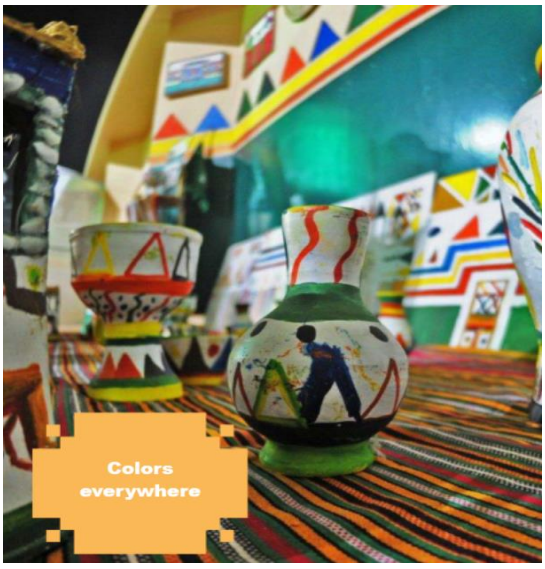
Special specifications

In the Asiri House, the ground floor is usually used for livestock and preserving grains and food, while the second floor is for housing and living, and women contribute to decorating the house with what is called the Asiri “Qat” art, so that it becomes an unparalleled architectural painting. The architectural style in the south also differs from one region to another, and the colors used to decorate it differ. The specialists differentiate between four main regions: Al-Hadba (Najran), Al-Sarat (Abha, Al-Baha, Baljurashi, and Al-Namas), Al-Isdar (Fifa, Rijal Almaa’, and Dhi Ayn) and the Tuhama region (Jizan and coastal areas).










Stone homes in Almaa'


Almajlis

Farasani House

Farasani House

The architectural styles of houses in Tuhama and the coasts of the southern Red Sea differ from those in the plateaus and mountains. It is noted that the design of the buildings in the plains of Tuhama and the coast takes a horizontal shape consisting of one floor with large, spacious areas, unlike mountain houses, which take a vertical orientation due to the unevenness and scarcity of suitable land for building. Farasani house is also characterized by its heavy reliance on Qur'anic decoration, the use of raw stucco, and colored windows.

The most important sections of the house:

1) Al-turaha:

It is a courtyard used for sitting and sleeping at nights, and chairs are spread over it for men to sit on.

2) Al-esha:

It is a conical room adjacent to the house, built from trees available in the area. Its diameter is 6 meters on average. It has two doors that act as an air duct, in addition to the method of its construction that reduces the impact of humidity and heat.

3) Al-malhab:

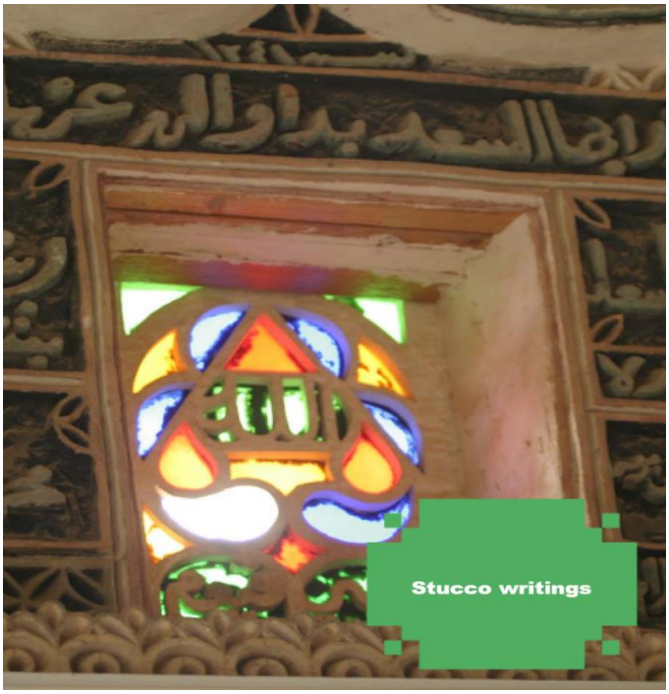
It is the kitchen and is usually on the highest floor of the building so that its smoke does not cause inconvenience to the family and guests.

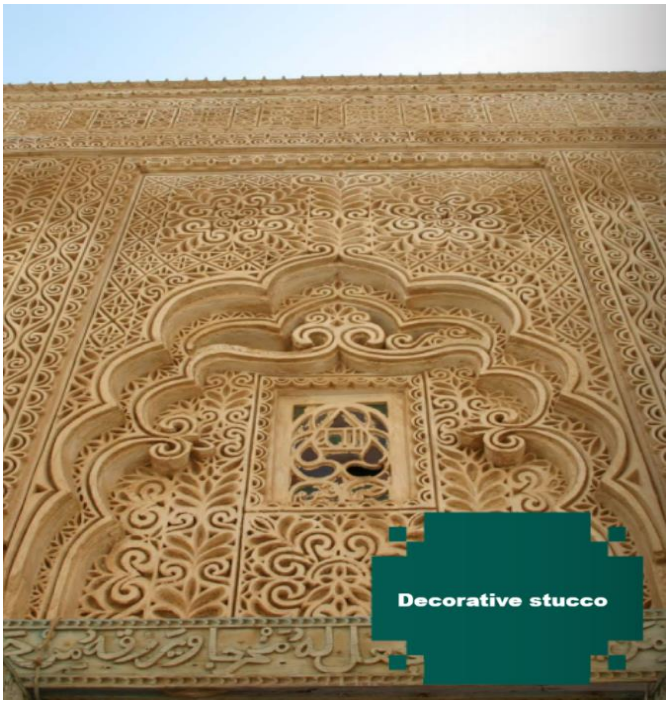
4) Al-qubul:

A courtyard on the other side of Al-esha is covered with clay and decorated.

Special specifications

The Farasani House is characterized by its delicate stucco decorations and distinctive furniture. It is noted that these houses are open to the external environment and inspired by architectural styles brought by pearl merchants and fishermen from India, Yemen, and Abyssinia. They greatly developed their Islamic decorations, using raw stucco that is abundantly available in its mines in Farasan.






Mosque


Decorative stucco formations

Causes of damage in historic buildings

Causes of damage in historic buildings

This step give an overview of the extent of cracks, wet spots, rising damp etc. Explore examples of what to look for and guides on possible remediation action in case cracks, wet spots, algae, mold growth, frost damage etc. are identified.

High levels of moisture often result in several types of deterioration and thus reduce the service life of building components. Moisture induced damages include mould growth, wood decay, salt efflorescence, algae proliferation, and frost damage. The presence of moisture in porous materials might further increase the thermal transmittance through walls and thereby the overall heat loss of the building.

There issue different causes for a visual assessment of building. Each cause holds answers on what to look for, types of risks, why it occurs, where to look and possible solutions.

1) Frost damage

Frost damage in porous building materials can originate from a variety of physical frost impacts, of which the volume increase of the water-to-ice phase change is the most widely known. Such frost damage is mainly manifested through scaling of the outer surfaces e.g in ceramic bricks and natural stones.

What to look for

Scaling of outer surfaces in bricks means that typically the outer 5-15 mm of the surface is peeled off in single stones or larger areas. This can be in moist areas but also apparently random on facades. Single stones with frost damage indicate that at least these stones are more sensitive than the rest of the stones. A visual inspection of the existing facade may reveal evidence of frost damage from the past, which logically is an indicator of potential future frost damage. In these cases, the application of internal insulation should not be discommended.

Risks

Frost damage is commonly solely related to aesthetical problems, particularly scaling of the exterior surface of the masonry wall, which normally do not lead to structural problems except for very extreme cases. Given more frequent and intense freezing conditions though, which penetrate deeper into the wall, the risk for structural damage may rise when adding internal insulation, if the material is very sensitive to frost damage.

Why it occurs

Porous building materials experiencing high moisture contents and low frost temperatures are at risk for frost damage. If pores in the material are filled with water that freezes and therefore expands, scaling of the outer surface may appear. However, some materials are more frost resistant than others, which depends strongly on the porosity and strength of the material.

Three conditions must be fulfilled for frost damage to occur:
•The material must be sufficiently wet
•The temperature must be sufficiently low, so that water in the material can freeze
•The material must be sensitive to frost damage.

Where to look for risks

The outer surface layers of historic masonry walls, including plinths, corners, are normally exposed to the highest risk for frost damage. In porous building materials, both moisture and temperature levels depend on the wall orientation. The prevailing direction for wind-driven rain in Europe is South-West while the lowest facade temperatures occur in North-faced facades. It is subsequently difficult to predict which is the most exposed orientation with respect to frost damage. Areas close to the ground may also be at high risk, as rising damp may cause high moisture contents in this area.

What to do

If the material is wet because of leakage in pipes or rising damp, these moisture sources must be remedied. If there is no extraordinary moisture source, the material may be too sensitive for its use, and internal insulation will increase the risk of further frost damage. Evaluating the frost sensitivity of the existing material is a job for experts; it requires an extensive experimental effort, wherein a large number of material samples has to be available.

2) Wood rot

Rot or wooden decay is caused by fungal attack on wood. Different fungal species that need high moisture (typical higher than 20 weight % in wood) favor wood as nutrient. The most common species are dry rot and brown rot.

What to look for

Wood rot occurs where wood is in contact with moisture, usually in presence of condensation or water leakages from pipes or leaks in the building envelope, typically from roofs. The wooden construction will be weakened and therefore softer than sound wood, which can be tested with a thin knife or awl. The appearance of wood rot depends on the fungal species that have caused the attack.

Risks

A rot attack causes wood decay, resulting in reduced strength and ultimately collapse of the wooden construction. How fast a rot attack develops depends on the available moisture. If moisture supply is stopped, the attack stops but will return if moisture again becomes available. Some fungal species need long time exposure to high moisture content before the wooden construction weakens substantially, while other species weakens the wooden constructions fast if the conditions especially favors these species. Fungal growth can – depending on the species – result in unpleasant odor and emissions, which must be considered as an indoor problem. Depending on exposure and immunological reactivity of the inhabitants the inhalation of airborne micro-organisms and their metabolites of some species may cause respiratory symptoms.

Why it occurs

Rot or wood decay caused by fungal growth is a failure mechanism for wooden constructions that is closely linked to moisture, as high-water activity is a prerequisite for fungal growth. Consequently,

fungal growth starts when the moisture content in wood exceeds a threshold value. The threshold value depends on different factors:

•Time of wetness, i.e. time above the certain threshold value
•Previous attacked wood has a lower threshold value than sound wood
•Temperature

Some fungal species (dry rot) can transport moisture over several meters, and through other materials than wood, enabling rot attack far away from the moisture source.

Where to look for risks

In historic masonry facades, wood is mostly used for half-timbering in external walls. Although structural floors are not a part of the wall, wooden beam ends and supporting laths may be placed in the external walls and therefore in direct contact with bricks or stones in the external wall. Consequently, the moisture content of the embedded timber will be dependent of the moisture conditions in the wall. Condensation or liquid water sources e.g. penetrating rain are usually a prerequisite for fungal growth. If the building is internally insulated with systems that contain wooden materials e.g. wooden framing, there is a risk of rot if condensation can occur due to insufficient vapor barrier or if water from driving rain is trapped in the internal insulation.

What to do

The most important measures to minimize or prevent rot attacks are:

•Controlling the moisture, ensuring the moisture level will not exceed the threshold value, coupled with a temperature threshold
•Prevent water ingress into the wall; e.g. make sure joints in brick walls are filled, and with no leaks from rainwater drainage systems or through roofs
•Limit the use of wood in critical parts of the envelope

If parts of the original structure are renewed it is possible to choose

other materials, e.g. replacing wooden beam ends with concrete beams. When parts of the construction are replaced, not only the damaged wood is removed; sound wood must also be removed to create a safety zone. How much sound wood that should be removed depends on the fungi species.

3) Rising damp

Rising damp is the transport of moisture from the ground, into the construction and up above ground level by means of capillary forces in porous building materials as brick and mortar. Rising damp can appear on external walls, or even on internal walls, and moisture accumulation can cause damage to the surface treatments and load-bearing elements, e.g. wooden floor slabs.

What to look for

Moisture in the façade can appear as darkened areas/wet spots and when it appears to be provided from below, the cause is likely rising damp. Rising damp can also be seen internally e.g. in basements or walls near ground level.

Risks

Moist areas in façades appear when the porous masonry is in contact with moisture and absorbs water by capillary forces and due to water pressure. There are several sources from which the water in a moist façade can originate, including;

•Ground water, infiltrating water (seepage of surface water through

the ground) or damp soil surrounding the foundation or basement walls
•Defective piping (either underground plumbing or external drainage systems)
•Surface water (precipitation in the case of the terrain being sloped towards the building)
•the ground) or damp soil surrounding the foundation or basement walls
•Defective piping (either underground plumbing or external drainage systems)
•Surface water (precipitation in the case of the terrain being sloped towards the building)

Why it occurs
Porous building materials experiencing high moisture contents and low frost temperatures are at risk for frost damage. If pores in the material are filled with water that freezes and therefore expands, scaling of the outer surface may appear. However, some materials are more frost resistant than others, which depends strongly on the porosity and strength of the material.
Three conditions must be fulfilled for frost damage to occur:
•The material must be sufficiently wet
•A phase change must occur in the material
•The material must be sensitive to frost damage.

Where to look for risks
All areas close to the ground i.e. outside at the plinth, in basements both inside and outside, and in walls at ground level. Mainly in buildings where bricks or natural stones have been used close to or in the ground.

What to do
Rising damp can sometimes be mitigated according to the moisture source; e.g. repair of defective piping and wrongly sloped terrain may alleviate the moisture source, while moisture from damp soil can be reduced by installation of a drainage system on the external side of the walls below ground. To prevent moisture from migrating upwards via the

pore channels in the construction, physical damp-proof courses (moisture barriers) can be installed in the perimeter of the wall. Physical moisture barriers can be of steel plates that are vibrated into mortar joints in the depth of the masonry construction if the joints are continuous. It is also possible to saw through the wall thickness, a section at a time, and place either steel sheets or reinforced roofing felt as moisture barrier.

4) Mold growth

Mold are microscopic fungi belonging to different biological groups and consisting of many species. They live on surfaces of materials, use easily assimilated nutrients for growth and produce airborne spores. Mold fungi are widely spread across different environments on the Earth, and no natural place with air are free from spores.

What to look for

Extended mold growth on building materials may be visible to the naked eye. Often it appears as black, green or white discoloration at surfaces. Some fungi produce pigments in their hyphae and spores that can cause this discoloration, while others lack these pigments. Therefore, mold growth is not always visible to the naked eye. Therefore, extensive mold growth may be present in buildings even though there are no clear signs. Typical warning signs can be damp surfaces, dried out water stains and rusty nails in the construction.

Risks

Mold in buildings may have negative effect on the perceived indoor

environment. Human health may be adversely affected due to the spread of particles, toxins and volatile organic compounds from the mold fungi to the indoor air. Inhalation of airborne microorganisms and the metabolites may lead to immunological reactions leading to different health issues. Furthermore, mold may produce odorous substances, which affect the perceived indoor environment. Due to renovation the costs associated with this growth are substantial.

Why it occurs

The main environmental factors affecting mold growth in building structures are humidity and temperature; moisture being the crucial factor. Suitable conditions for the growth and reproduction of different mold fungi vary. Some thrive at relatively low values of relative humidity (RH = 75%), while most fungi require values of RH (90-95 %) for optimal growth in room temperature. Different building materials vary in their susceptibility to mold growth; some can withstand high moisture content better than others. Mold growth is the result of a complex interaction between all these factors; environmental factors and duration, material properties and the characteristics of mold fungi present.

Where to look for risks

For mold to grow on material there must be nutrients in the form of simple carbohydrates present on the material. All material organic compounds or surfaces with dirt are therefore at risk for mold growth if there is sufficient moisture available. This will typically be the case at cold surfaces especially in corners and behind furniture where the ventilation is low.

The original external wall in historic buildings often consists of inorganic building material and may therefore be considered as robust from a mold perspective. However, there are also adjoining frames, beams, windows, doors, added insulation and surfaces containing organic compounds, that needs to be inspected. Furthermore, simple dust contains organic material, therefore mold can appear at cold surfaces due to high relative humidity in these areas.

What to do

If the material is wet because of leakage in pipes or rising damp, these moisture sources must be remedied. Changing the temperature in the outer surface is difficult without changing the appearance of the wall. Therefore, if there is no extraordinary moisture source, the material may be too sensitive for its use, and internal insulation will increase the risk of further frost damage. Evaluating the frost sensitivity of the existing material is a job for experts; it requires an extensive experimental effort, wherein many material samples must be available.

5) Algae growth

Algae and cyanobacteria are micro-organisms able to create a biofouling film covering building surfaces. These microorganisms can tolerate climatic variations, maintaining the metabolic activity only when appropriate combinations of dampness, warmth and light are present.

What to look for

Biofouling on building façades form patinas varying in extent, thickness, consistency, and colour from green to grey and black. This may cause readily recognizable stains, readily recognizable stains on the material surfaces. The bright green colour usually takes place on areas that are sufficiently moistened and not directly exposed to sunlight. Algae colonization appears on a large variety of façades (i.e. on stone, brick, plaster and mortar) and it is fostered by the presence of water on the material's surface. On the contrary, during dry and cold weather they tend to die, leaving a dirt deposit

which later permits a rapid new growth as soon as suitable weather comes again.

Risks

Algae and cyanobacteria are the main colonizers of building façades, and later they may favor the growth of mold, lichens, fungi and other microorganisms. The biological colonization of external façades by microorganisms can change the aspect of the surfaces and can even compromise the durability of materials. In addition to the aesthetic deterioration, algae and cyanobacteria may also cause a biochemical and a biophysical deterioration of the building façade, like mechanical stress, and loosens mineral grains especially on stone surface.

Why it occurs

Algae growth is influenced by several factors such as climate, building design and façade materials. Among the most important ones are environmental conditions, temperature and free water availability. Façades exposed to dominant winds are more easily colonized compared to other sides of the building. Since the wind may transport both rain and biological contaminants, a façade which is often wet by rainfall promotes the growth of algae.
The main causes for wetting of façades are mainly given by wind driven rain, leaks from rainwater drainage systems and dew water. However, algae and cyanobacteria can survive dry periods and restart their growth when enough water is available. Therefore, the drying of façades during the day is not enough to prevent algae colonization.

Where to look for risks

•Surfaces with water streams often moistened for long periods
•Porous or rough building materials such as bricks, stones and mortar
•North-facing walls not directly irradiated by the sun
•Balconies, roof overhangs and roof drains
•Damaged waste-water pipes

What to do
Case-by-case evaluation and tests are needed for a proper recommendation to solve the problem.
Overall, three methods are available:
1.Mechanical methods remove biofilm, stains and patinas from contaminated elements either by hands or tools
2.Physical intervention using ultraviolet (UV) radiation for surface treatments
3.Chemical methods include the use of biocide agents of synthetic origin like pesticides and disinfectant. Notice that legislation on chemicals approved for this purpose differ from each country.

6) Salt Efflorescence

Salt efflorescence is an expression for the deposits of salts on the surface of masonry. The deposition occurs when moisture in the wall contains soluble salts, and this moisture is brought to the surface, where it evaporates, and leave the salt crystals behind. The crystals may cause loss of material from the surface.

What to look for
Salt can appear as both white, powdery crystals, or as a white coating, and may appear both internally and externally of the building wall. The salt crystals can cause rendering and paint to peel off. But also, bare bricks and mortar may turn into powder starting from the surface.

Risks
Often, it is to be seen as an aesthetical surface problem with

efflorescence of salts, crust formation and damage due to salt crystallization (spalling, flaking of paint etc.). In other cases, damage may appear due to volume increase and high crystallization pressure, if the façade material isn't sufficiently resistant. The loss of material, e.g. joints, may cause water penetration in the wall. Furthermore, salt will bind moisture from the environment to the material, causing a constant high moisture content even after the moisture transport from e.g. ground water has stopped. Red bricks usually have a higher porosity when compared to yellow bricks, and thereby attract more moisture and salt.

Why it occurs

Salt efflorescence is an indication of the presence of moisture. Salts are water-soluble and can therefore be transported with moisture. When the moisture content decreases, salt crystals are accumulated, typically beneath the surface of the masonry. Due to expansion of salt, and crystallization pressure, salt can cause serious damage to masonry. The salts can originate from both the building materials themselves, from the soil, from pollutants in the surrounding air, or from road salt. Salt attracts moisture from the environment including the air. Thus, the moisture level is kept rather constant with the presence of salt, which will crystallize where the moisture level is not constant, i.e. at the surface.

Where to look for risks

Often salts will migrate with rising damp, so basement walls, or the façade near the plinth are often good indicators for presence of salt. Coastal buildings, and buildings by large roads salted eagerly in winter, are more exposed than other buildings in less saline environments. Damage in pedestal areas are typical. Also, special parts of buildings e.g. corners may be prone to higher salt concentrations due to urination. For a complete diagnosis of salt content in masonry, the salinity can be measured in drill dust samples, and should not exceed 0.5 % by weight.

What to do

There are different methods for salt remediation.

•With a planned drying, salts will reach the facade. These must always be removed dry on the surface.

•In the case of brick facades, the joints must be completely renovated up to at least 50 cm beyond the affected areas.

•In the case of partially high salt contents, the salt-loaded areas are removed, i.e. contaminated plaster or stones are removed, and new plaster or stone replacement is applied, resulting in a natural reduction of the salt content.

•Special coatings and its systems can be applied to the surface. After the plaster has been saturated with salts, the restoration plaster has fulfilled its function and must be removed.

In special cases, different chemical and physical processes can also be used.

Architectural Documentation

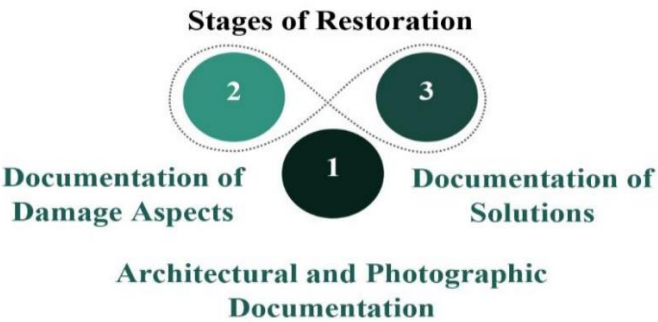
Architectural Documentation

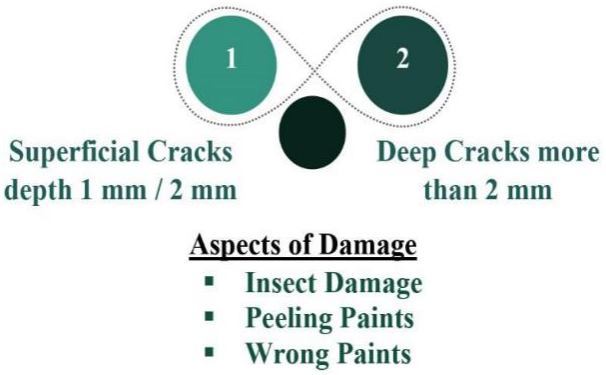
Architecture documentation for historical projects aim to the following:

1) The restoration aims to return the item to its original place and ensure documentation is completed for the date as well as the laws of the country and the competent authorities, such as Heritage Commission.
2) Every detail and documentation are created in collaboration with the Heritage Commission by submitting documents to the relevant Heritage Commission committee.
3) Architectural drawings of the building with signs of damage are submitted to Heritage Commission committee, which reviews these drawings and decides whether to accept or reject them.
4) A specific method for submitting to the Heritage Commission, then matching these drawings with the Heritage Commission committee, and finally approving the work.

Documenting Aspects of Damage in Historic Buildings:

1) All cracks are documented, sketched, written down, and signed.
2) A table is created to display the building's documentation.
3) The current situation of the building is documented for all these elements.
4) The staircase, ceiling, and armament work have also been structurally documented.





Treatment Strategy of Historical Buildings:

The preservation and restoration of historical buildings are referred to as historic preservation. When it comes to building maintenance, there are four basic types of treatment, or methods, that can be used to manage the property. Each has its own set of objectives and constraints.

1) Preservation: gives a high value to preserving all historical buildings through maintenance and repair. Besides, all materials added to the building are kept throughout its life, and work is completed only when necessary to prevent site deterioration.

2) Rehabilitation: emphasizes the preservation and repair of historical materials. In addition, it is a higher standard of protection because it assumes that the building has become so deteriorated that it requires repair to prevent further damage. It focuses on preserving the materials, features, finishes, spaces, and spatial relationships that give the building a historic feel while also allowing for additions that do not compromise the property's integrity.

3) Restoration: such as preservation, strives to keep as much of the original material as possible. Allowing material from other periods to be removed, the focus of restoration is to present the property at a specific point in history. As a result, some items or fixtures are repaired or recreated.

4) Reconstruction: is the most important type of treatment that allows for the recreation of extinct sites, landscapes, or objects using entirely new materials. Reconstruction should be referred to as "contemporary re-creation" because it is built on historical foundations but is new.

Restoration Process

Restoration Process

The following are the best practices for the restoration process:

1) The first step in the restoration process should be site analysis.

2) Extensive documentation is required. This includes making a list of all the elements and fixtures in the building. Each building element and feature, including their location and function, must be photographed, and documented in writing. It is an important step in understanding the site and the work that needs to be done.

3) Before beginning any work on the site, the maintainer will create a restoration group management policy. This policy will include a statement of purpose, a restoration plan that includes a list of all proposed changes to the site, a list of the site's current collection, join policies for new additions, unjoin policies for collection items that will be removed during the restoration process, caring instructions for the collection during the restoration process, and a section of guidelines. As the restoration process progresses, ethics must be followed.

4) All materials from the specified restoration period will be saved for future use in the restoration. This includes materials, architectural features, and design elements associated with the restoration period, such as painting or wallpaper. During restoration, non-period materials and architectural elements will be removed.

5) If a building, fixture, or design feature is damaged, maintainers must first attempt to repair it. A substitute will be made if this is not possible. If a feature is replaced, the new feature must match the original in color and design. Ideally, restorers would use period-appropriate materials, but this is not always possible.

6) If a building addition is required as part of the restoration,

these changes must be documented with historical documents and physical evidence. Restoration avoids conjecture and adding details that have not been proven will only harm the site's value and importance. If the building's design was not present during the specified period, it will not be included in the restoration.

7) Any restoration treatments that cause damage to the building or its historic materials will not be used. Because any treatment will influence the material. Therefore, restorers should carefully select the best treatment method for the material. A brick facade, for instance, will be processed differently than wrought iron.

Types of Restoration:

The types of restoration are consolidation restoration, decomposition restoration by releasing, finishing, or renovation. In 1936, Giovanni identified four types of restoration:

Practical Techniques in the Restoration of Architectural Formation Elements:

The term "repair" refers to the recovery of damaged chassis parts. The term "reconstruction" refers to the process of rediscovering completely damaged structural elements that have lost their structural function as a result of destruction.

Techniques for Restoring Architectural Formation Elements:

1) Restoration by Architectural Simulation and Reforming of Structural Elements: Physical simulation should be used to realize the matching relationship of an antique building related to sculpture, construction, and formation by using the same construction methods and materials and following the same pattern in the process of forming and renovating the building differently. The main ones are the extension of the same type of construction, materials, and construction methods, and the use of the same details.

2) Restoration by Stitching: When all of the structural elements operate independently, damage and collapse occur. The stitching is returned to the building with minimal structural continuity. In addition, the location and direction of the crack guide can be considered track stabilization according to building specifications.

3) Restoration by Injection: The injection is the internal grouting material under pressure used to strengthen the walls. The process of adding a bond in the form of a liquid to construction elements, such as the walls of a building, which rely on their symmetry and equilibrium by filling, particularly in the external double structure with core filler. As a result, the injection aims to fill the gaps inside the walls caused by the deterioration of the old work to re-join the wall with the internal filler and give it the necessary strength.

4) Restoration by Reconstruction: It was simple disintegration, fragmentation, partial demolition, or even mass destruction with the aim of structural and architectural reconstruction in the archaeological building's composition.

5) Restoration by Disassembly & Reassembly: Reconstructing and assembling the architectural formation's elements because the original elements are present, albeit scattered, as well as using the elements of the old building

without any additions in the process of reassembling all the pieces that could be stable.

6) Restoration by Reinforcement: This stage aims to improve the background of the decoration and reconnect the gypsum composition's elements.

7) Restoration by Rebalancing Tendencies: Most vertical elements are susceptible to leaning, particularly when subjected to lateral load stresses such as earthquakes and vibrations. The columns are the load-bearing elements in the various monumental buildings on which the roofs and arches rest.

8) Restoration by Stabilize Tendencies: Some buildings with leanings cannot be demolished, particularly brick minarets. The restoration plan was created by monitoring in all directions at various heights, monitoring its stability, and determining the severity of its tendencies based on the value of the tendencies for the height, thickness, and fence of movement, as well as the stability of this tendency.

9) Restoration by Completion: Operationally, in the field of restoration, the completion of archaeological buildings in their lost parts is one of the most important aspects of operations in the field. Because of the achievements of these processes to obtain the archaeological continuity of the building, with its structural, architectural, and decorative details, restoring all the details of the element means obtaining a clear picture of its original condition by respecting the original components and materials.

10) Restoration by Replacement: Restoration work aimed at still-existing but completely existing items has resulted in the loss of their ability and main functions.

11) Restoration by Casting: The process of duplicating a valuable item to use its aesthetic value in creating a complete composition without using it if damaged. This technique is especially important when the damaged structural elements cover areas that must be accessed and strengthened to prevent

the building from collapsing.

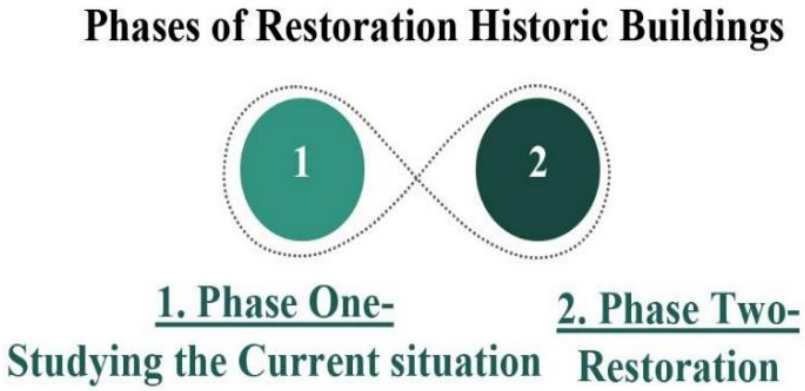
12) Restoration by Cleaning: Stain removal is not only a method of cleaning; it is also a method of preserving, treating, or preventing the effect of caries from dissolving. Furthermore, it is a method of maintaining the substance's effect stability.

13) Restoration by Reinforcement Using Iron Bonds: In the field of archaeological application, reinforcement operations are critical for accuracy and specificity. It deals with the surface structure and internal impact, which necessitates extreme caution to avoid internal distortion of the archaeological material's structure.

14) Restoration by Show Hidden Decorations: The restoration is based on revealing the decorations hidden behind the new paint while respecting the original material, design (originality) and removing additional elements that distorted or masked the building's old character.

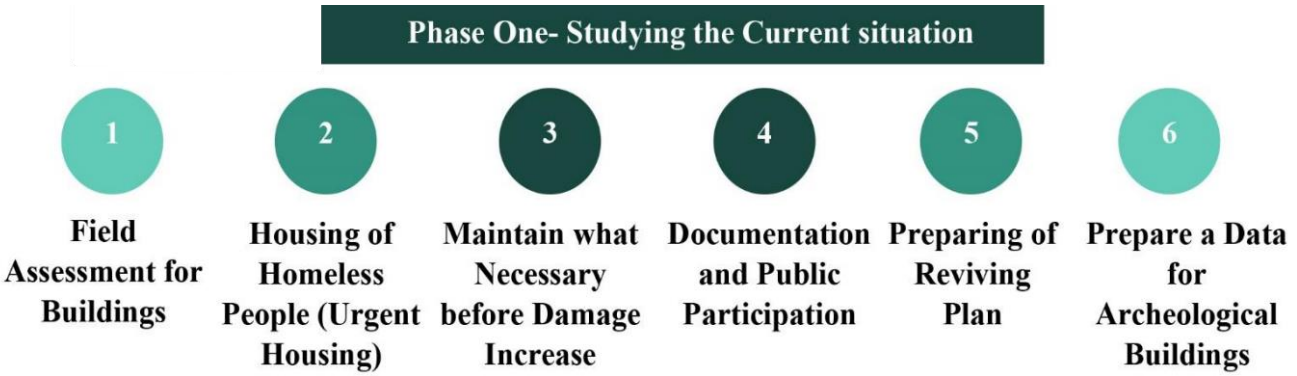
Stages of Historical Building Reconstruction and Restoration:

The stages are divided into two major sections. Inside historical buildings in various stages of reconstruction and restoration.



Phase One-Studying the Current Situation: This stage incorporates surveying, photographic, and architectural documentation, as well as considering the conditions of the affected population and studying the sites. Taking tests to prepare for plans, studies, and databases is also part of the process.

The steps to be taken at this point are outlined below:
In the first stage, the main steps must be taken (examination of the current situation).
1) Building field assessment: Building field assessment: This plan entails preparing a preliminary report in conjunction with international standards and references. It will be used as the primary reference file to achieve the goal.
2) Historical building damage ratings by international supplier agreements.
3) The first stage is documentation and public participation.



International conventions provide damage ratings for historic buildings. All damage, on the other hand, is identified and classified into five grades:
1) Minor damage: is sustained by non-structural elements.
2) Moderate damage: is sustained by non-structural elements, and minor damage is sustained by structural elements.
3) Heavy damage: is sustained by non-structural elements, and moderate damage is sustained by structural elements.
4) Heavy damage: is sustained by structural and non-structural elements, with some partial collapse.
5) Complete breakdown.

Based on International Conventions, Classifications of Historic Building Damage		
First degree damages	Minor damage is sustained by non-structural elements.	Blue
Second degree damages	Moderate damage is sustained by non-structural elements, and Minor damage is sustained by	Green
Third degree damages	Heavy damage is sustained by non-structural elements, and moderate damage is sustained by	Yellow
Fourth degree damages	Heavy damage is sustained by structural and non-structural elements with some partial collapse.	Orange
Fifth degree damages	Complete breakdown	Red

Preparation of a historical building database:

This step entails creating a database for all historical buildings by entering survey and field documentation data for analysis, data collection, and the creation of analytical maps.

This database has the following characteristics:

Photographing all buildings (at least one photo for each building) and documenting information on the physical condition of buildings, services, architectural styles, and historical periods.

Phase Two- Restoration.	
1	International standards should be followed when performing restoration.
2	It is preferable to use modern technology and materials from the local area.
3	It must be recycled and reused.
4	If reconstruction costs are not available, decommissioning procedures should not be carried out.
5	Debris must be removed. The workplace must be fortified in preparation for restoration.
6	After the completion of historical building restoration, scientific documentation must be completed.

Phase Two-Restoration:

A strategic plan for the restoration process is developed based on the findings of the first stage's research into the current situation. This is accomplished by defining the working mechanism, materials, preparations, and equipment.

Furthermore, during this stage, we must approach the restoration process with caution and avoid making any rash decisions on the job site.

Material Condition:

An increasing number of heritage buildings are being demolished because of their age. The most common materials used in heritage buildings are stone, concrete, steel, and wood. Most of the historic buildings were constructed of stone and have survived since antiquity due to the durability of the building material. However, without protection, stone can quickly deteriorate, especially in our modern age of pollution and climate change to gain a better understanding of the impact of various technical factors in selecting repair materials and analyzing damage. The maintenance engineer must consider factors related to longevity and the preservation of the architectural character, such as form, style, and their constituent materials, such as stone, brick, glass, metal, and wood. In this context, the term refers to the "professional application of a body of science, art, craft, and technology as a conservation tool."

Respect the original material

1) There is a strong relationship between the techniques and materials used in the restored scheme.
2) Replacements for missing parts must be harmoniously combined with the whole while remaining distinct from the original. Additions are not permitted unless they do not detract from the building's interesting features, as well as its traditional setting and relationship with its surroundings.
3) For structural restorations, the use of traditional techniques and materials is preferred.
4) Only techniques and materials that allow for easy corrective action should be used.
5) Stucco and mosaic decoration must be protected and prevented by taking the necessary precautions. This may

preclude the use of certain strengthening techniques that could cause harm.

Cleaning and Removing Paint:

Cleaning and removal of paint from exterior building and facade materials may be permitted if the following conditions are met:

Techniques for repairing or removing materials for restoration:

1) Painting: Facades can be approved for painting and restoring building interior items that were originally or historically painted to protect them from damage and restore them to their historical appearance. The paint must be physically and aesthetically compatible with the original building or historic paint. Except for the following case file, the color shall be consistent with the date of the same painting of buildings of type, style, and age. Unless the color is part of a later major change, the suggested paint color for historically painted buildings must match the color of the primary building.

2) Chemical Detergents: Chemical cleaners can be used if they do not harm the historical materials.

3) Coating: Paint to protect the building facade and interior elements from damage, as well as coatings of non-greasy materials such as metallic paint, may be approved if water seeps through the facade or features due to surface deterioration. Although it is always preferable to repair damaged materials properly, a coating that temporarily protects the facade or interior items from further damage can be approved.

4) Natural and Historic Cast Stone Repair: Natural stone repairs, historic cast facades, and stone elements are all acceptable. The deteriorating stone is cut back into the intact stone, and the new surface is locked into it.

5) Brownstone Repair: Brownstone can be approved for the repair or resurfacing of deteriorating facades and elements that

frequently need to be repaired. This requires the skillful re-creation of decorative elements. The extent of deterioration is determined, as well as the method and materials used, if applicable.

6) Repointing: Repointing is one of the most common types of building facade repair work. It is frequently replaced and determining the original color can be challenging. This work must be closely monitored to ensure that there is no overflow or widening, which could cause irreversible damage to the bricks and change the appearance of the historic facade.

7) Brick and Terra Cotta Repair: If any of the bricks become damaged, they can be replaced with new bricks that match the historical bricks. If the brick is cracked, repair plaster or epoxy can be used in some cases.

8) Restoration of Ornamental Materials Sheet Metal, Cast Iron, or Wrought Iron: Metal repairs, including sheet metal, cast iron, and wrought iron used in fences, handrails, cornices, porches, cladding, and lintels, may be approved if they achieve the following criteria: small holes and tight quarters. The damage can be repaired. Solder, spot welding, anchors, fasteners, composite fillers, and sealants are all used. All repair materials must be compatible with the metal's expiration date.

9) Restoring Wooden Details: The wood used for cornices, cladding, window frames, windowsills, sills, doors, and decorative elements is repairable if the repairs achieve the following criteria: Wood putty can be used to make minor repairs. Another method for repairing larger areas of lost or degraded wood would be to replace portions of historical wood with new pieces of wood. All repair materials must be timestamped to match the wood.

10) Other materials for repair: Other materials, such as chips, plastic, synthetic rubber, blinds, walls, and formwork, may be repaired if the following criteria are met. Repairs must

match the physical and aesthetically pleasing characteristics of the original or historic materials. Minor repairs using alternative materials that do not detract from the appearance of the original materials may be approved. When possible, historic material replacement is preferred over replacement. However, if materials are too degraded to be repaired, replacement with historical materials that can be replicated and reinstalled can be approved. Natural and historical cast stone can be replaced with modern cast building materials.

11) Natural Stone Replacement: Cast stone and natural stone replacements can be approved if they achieve the following criteria: cast stone and natural stone (other than brownstone).

12) Brick and Terra Cotta Replacement: Brick and terra cotta (crushed clay and ceramic unit construction) are acceptable replacement materials. Bricks must be replaced in the same manner. Alternative materials are not permitted to be used in place of bricks.

13) Replacing Ornamental Sheet Metal and Cast Iron or Wrought Iron: Replacement materials may include ornamental sheet metal, cast iron, or wrought iron.

14) Replacing Wood Features: Wood elements may be approved for replacement if they achieve the following requirements: At the primary interface, wood must be replaced in kind. However, painted wooden elements and sheet metal painted on the facade elements can be used interchangeably (e.g., cornices).

15) Replacing Other Materials: Materials such as laminates, plastic, synthetic rubber, curtain walls, and poured concrete may be substituted if the replacement meets the following criteria: physical, aesthetic, and other characteristics that are similar to the original materials. Minor repairs can be made with alternative materials as long as they do not detract from the appearance of the original materials.

16) Replacing or Recreating Missing Facade Elements: Every effort should be made to preserve the historic building's existing structures. However, some facade elements, such as roofs and cornices, ramps, storefronts, windows, door fittings, ironwork, and balconies, may be missing in some cases. Restoration of missing facade elements can be approved if the items are returned to their original files or historical appearance and meet the following criteria: the replacement elements must be designed using historical photographs, physical evidence of the building, or historical drawings.

17) Reconstructing Building Facades: Reconstruction of a building facade is permitted if the entire facade has severely deteriorated, is unstable and the work achieves the following criteria: Facades can only be approved for the reconstruction of buildings in historic districts, not for single buildings seeking special permission for a change in use or bulk.

18) Windows and Doors: Repair windows, domes, and doors while preserving the original fabric as much as possible and preferring replacement whenever possible. The original historic glass must be preserved (crown, cylinder, plate, drawn, embossed, stained glass, glass with seeds, packets, or other prominent inclusions).

19) Window and Door Carpentry: When possible, windows and doors should be repaired by carefully gluing matching new timber to precisely follow the original profile using traditional techniques and glue. When new windows or doors are required, they should be glazed in the same manner as the originals and constructed from precisely matched timber sections that adhere to the original design and profiles. Wherever possible, it must reuse the original iron materials. Where necessary, new, historically appropriate iron materials that achieve modern security and egress requirements while maintaining appropriate style and quality are chosen. It must use screws with the same type of hole as the original installation.

20) Metal Windows and Doors: It must keep and repair as much of the original tires, operating equipment, and iron materials for reuse and repair any damaged sections. This should be done after the carpentry facades have been decorated. For metal windows that are an original design feature.

21) Exterior Paint for Windows and Doors Carpentry: Painting using traditional techniques and high-quality oil-based paint preparation as directed by the paint manufacturer's instructions.

22) Carpentry Repairs: When internal carpentry sections need to be repaired or replaced, we mold new wood of the appropriate species and quality to the original profile, cutting and installing it according to best practices.

23) Ornament: Because it is part of a historically significant decorative scheme, interior decoration with paint schemes should be based on a research study of the interior.

24) Service Facilities: Heating installations within the building envelope must be installed separately and in harmony with the historic fabric. The service work plan must include testing of electrical installations as well as any improvements discovered because of the testing. Renovation of significant historic electrical and mechanical installations should be considered.

25) Metalwork: The type of ironwork to be repaired, such as mild steel, cast iron, or wrought iron, must be determined early on to guide subsequent work.

26) Cast Iron: Given the application, materials, and historical significance, of each project and the use of the most appropriate repair technique should be evaluated. Under certain conditions, cast iron can be welded or brazed by professionals using high-nickel electrodes. It may also be more convenient to repair or install the board by drilling and tapping adjacent components. Cold metal stitching is another option. It is also possible to consider recasting lost components using

conventional techniques. Design and quality must be consistent with what is already in place.

27) Wrought Iron: Wrought iron must be removed and repaired by experts in the field. The repaired wrought iron is made by using only recycled wrought iron of suitable quality or pure iron if it is unavailable.

28) Steel: Using appropriate cleaning systems and anticorrosion treatments, as much of the historical steelwork as possible should be preserved. When repairs are required, the appropriate steel grade, matching sections, and original installation details are used.

29) Decoration and another Metalworking Repair: Ceiling vents, single-vent fans, balustrades, gates, and other historical architectural elements must be repaired using traditional methods and materials.

30) Shop Drawings: As a condition of approval, shop drawings (a drawing or set of drawings produced by the contractor, supplier, or designer) are frequently required. If requested, shop drawings must be provided before any fabrication or installation. In some cases, shop drawings may necessitate a permit before it is issued. Graphics must be extremely detailed and precise.

31) Sample Review: Before beginning work, samples of materials, methods, and finishes may be required for review and approval.

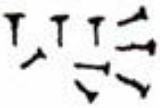
32) Conditions Report / Assessment: Estimate/Report on Condition When large amounts of material or significant architectural features (e.g., cornices) are proposed for replacement, a condition report or evaluation of deteriorated conditions that warrant replacement should be submitted. High-quality photographs of proposed worksites must be included in the report. It must determine the material, such as wood, limestone, or terra-cotta bricks.

Construction tools used in Saudi Arabia

Construction tools used in Saudi Arabia

1) Masaha and Atala: used in cutting of stones.
2) Shahouta: used in shaping the stones.
3) Qadum and Koriek: used in preparing stones.
4) Al-qadda: 18 karat measuring instrument.
5) Al-rahmaneya or Sakkala: it is scaffolding used to work at the exterior of the building in upper levels.
6) **Hand drill "Darbakin":** produce rapid rotary motion of a rod. It consists in holding the rod vertically between both hands and moving these back and forth, in opposite directions, as in rubbing them. The rod typically is one or two feet long and half an inch in diameter, used to make holes.
7) Juffair: It is a basket made of wicker and palm leaves used to carry building materials.
8) Haib: a long, solid and heavy iron pole used for excavation, demolition and crushing work.
9) Hammer "Mitraqa": used for breaking stones and other construction works.
10) Qadum: big hammer.
11) Farza: larger than Qadum, and it is used for breaking large stones and for demolition work.
12) Qabban: It is a metal weight connected to a string, used vertically to adjust the surface level of the row of stones.

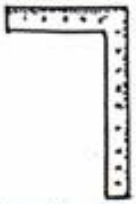
Nails



Screws

Plane

Drawknife



Carpenters' steel square

Hammer

Bit and brace

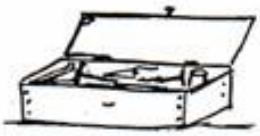
Coping saw

Pliers

Hand saw

Jack knife

Plumb line



Tool chest

Broad axe

Double bitted axe

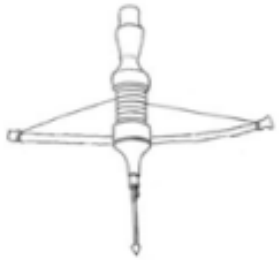
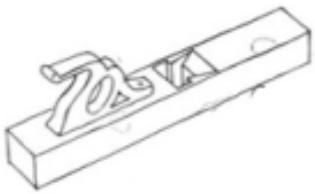
Chisel

Shingle horse (Schnitzel Bank)

Cross cut saw

Trowels

Tack hammer

	
Darbakin	**Qabban**
	
Saw	**Fara**
	
Mitraqa	**Haib**
	
Mastaren	**Juffair**

Adobe Architecture

Adobe Architecture

is a building material made from earth and organic materials. Adobe is Spanish for mudbrick. In some English-speaking regions of Spanish heritage, such as the Southwestern United States, the term is used to refer to any kind of earthen construction, or various architectural styles like Pueblo Revival or Territorial Revival. Most adobe buildings are similar in appearance to cob and rammed earth buildings. Adobe is among the earliest building materials and is used throughout the world.

Composition

An adobe brick is a composite material made of earth mixed with water and an organic material such as straw or dung.
The soil composition typically contains sand, silt and clay. Straw is useful in binding the brick together and allowing the brick to dry evenly, thereby preventing cracking due to uneven shrinkage rates through the brick.[12] Dung offers the same advantage. The most desirable soil texture for producing the mud of adobe is 15% clay, 10–30% silt, and 55–75% fine sand.[13] Another source quotes 15–25% clay and the remainder sand and coarser particles up to cobbles 50 to 250 mm (2 to 10 in), with no deleterious effect. Modern adobe is stabilized with either emulsified asphalt or Portland cement up to 10% by weight.
No more than half the clay content should be expansive clays,

with the remainder non-expansive illite or kaolinite. Too much expansive clay results in uneven drying through the brick, resulting in cracking, while too much kaolinite will make a weak brick. Typically, the soils of the Southwest United States, where such construction has been widely used, are an adequate composition.

Soil Source:

•Mud required for building can be taken from the plot itself.
•The soil is collected after depth of 60cms only.
•As the top layer is full of organic matter, it isn't used.
•Below it is sand and clay which are dug out in heaps.
•Do not use hard rock.
•Soil to be used should be devoid of organic matter.
•Top should be replaced after excavating.

Soil Type:

1.Gravel: Small pieces of stone varying from the size of a pea to that of an egg.
2.Sand: Similar small pieces of stone (usually quartz), which are small but each grain, is visible to the eye.
3.Silt: The same as sand except that it is so fine that you cannot see individual grains.
4.Clay: Soils that stick when wet – but very hard when completely dry.
Organic Soil: Soil mainly composed of rotting, decomposing organic matters such as leaves, plants and vegetable matter. It is spongy when wet, usually smells of decaying matter, is dark in color and usually damp.

Soil Usability

1.Gravel: alone is of no use for mud wall building – the tiny lumps of stone have nothing to bind them together.
2.Sand: similar to gravel, it is of no use for wall making by itself – but if mixed with clay, it is the ideal mud wall building soil.
3.Silt: by itself is also no good for building walls. It will hold together but is not strong. Furthermore, it will not compact so it

is also of no use for pressed blocks or rammed earthwork.
4.Clay: can be rammed or compressed but in drying out they often shrink. During the monsoon they get damp and expand again and crack form.
5.Organic Soils: are mainly useless for wall building.

Tests:

•**There are two kinds of tests:**

- Field tests
  - Color tests
  - Touch and smell test
  - Biscuit test
  - Hand wash test
  - Cigar test
  - Adhesion test
- Lab tests
  - Sieve test
  - Sedimentation test

Color test

•Procedure

- Observe the color of soil.

•Interpretation

- Deep yellow, orange and red, ranging to deep browns indicate iron content which is good as building mud.
- Greyish or dull brown, ranging to dirty white indicates more clay.
- Dull brown with slightly greenish color indicates organic soil.

Touch and smell

•Procedure

- Rub small quantity of dry soil on palm to feel its texture.
- Moisten the soil and rub again.

•Interpretation

- Soil that feels course when dry but sticky when wet contains lumps of clay.
- Soil that feels course when dry but gritty when wet contains sand.
- Soil that feels course when dry but little gritty when wet contains silt.
- If the wet soil gives off musty smell, then it contains organic matter.

Biscuit test

•Procedure

- Make a smooth paste from the soil removing all gravels.
- Mold it into a biscuit of 3cm diameter and 1cm height.
- Leave it to dry and observer for shrinkages or cracks.
- Break the biscuit to noting how hard it is.

•Interpretation

- If biscuit cracks or leaves gap from the mold, then it contains more clay.
- If its very hard to break, then soil contains more clay.
- If it breaks easily and can be crumpled between finger, then it has good sand-clay proportion.
- If breaks and reduce to powder, then the soil has more sand or silt.

Hand wash test

•Procedure

- Play with wet soil till your hands get thoroughly dirty.
- Wash your hands to see how difficult it is to clean.

•Interpretation

- If hands get cleaned quickly, then soil contains more sand.

- If it takes little time to clean and feels like flour, then soil contains more silt.
- If it feels soapy or slippery and takes time to clean, then soil contains more clay.

Cigar test

•Procedure

- Make a smooth paste from the soil removing all gravels.
- Roll it on palm to make a cigar.
- Slowly push it outside your palm.
- Measure the length at which it breaks.

•Interpretation

- Length below 5cm – too much sand.
- Length above 15cm – too much clay.
- Length between 5cm to 15cm – good mixture of sand and clay.

Adhesion test

•Procedure

- Make ball out of wet soil.
- Pierce a knife into it and remove.
- Observer the knife after removing.

•Interpretation

- If little soil sticks on the knife, then it has more silt.
- If lot of soil sticks on the knife, then it has more clay.
- If the knife is clean after removal than the soil has more sand.

Sieve test

•Procedure

- Pass soil from series of standard sieves set on top of on another with finest sieve at bottom.
- Observer the soil collected in each sieve.

•Interpretation

- Silt will be collected in lowermost sieve.
- Gravels will be collected on top.
- Sand and lumps of clay will be collected in intermediate sieves

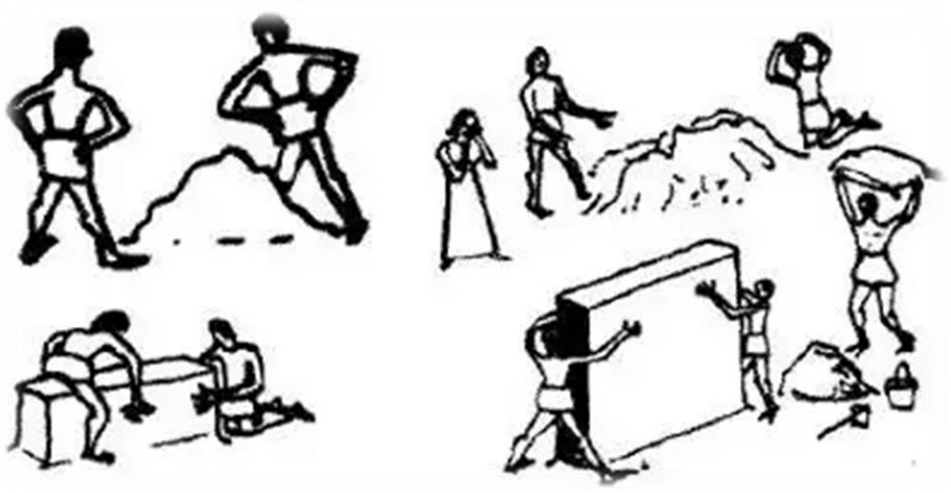
Sedimentation test

•Procedure

- Take a transparent cylindrical bottle or jar of 1Lt. Capacity.
- Fill it with ¼ soil and ¾ water.
- Shake well and allow it to settle for 30 min.

•Interpretation

- Coarse gravels will be settled at bottom, followed by sand, silt and clay on top.
- Measuring the layers will give us the approximate proportions of each content.



•**Stabilizer:**

When the available soil is not suitable enough for construction then the soil can be used by manipulating its composition by adding suitable stabilizers.

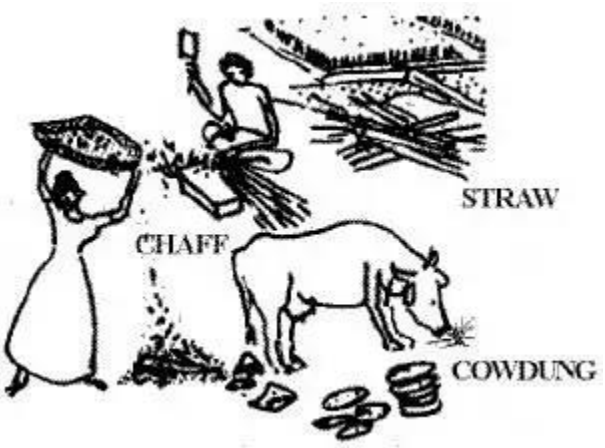
- Stabilizing enhances the given property of the soil type.
- Increase Tensile and Shear strength.
- Reduce shrinkage.

•Most common and effective stabilizer is Soil itself.

•Cement, is the best example of a modern contemporary stabilizer.

•Various other indigenous stabilizers include

- Straw
- Plant Juices
- Gum Arabic
- Sugar Or Molasses
- Cow Dung
- Animal Urine
- Tannic Acid
- Oil



COB

•With only a little water to form a very stiff mud, a large lump is roughly molded into the shape of a huge elongated egg.

•The usual size is anything between 12 to 18-inches, (30 to 40-cm) long and about 6-inches (15-cm) in diameter.

•A row of these cobs of mud are laid neatly side-by-side – preferably somewhat pressed together.

•Then another row of cobs is laid on top.

•When three or four courses have been laid, one above the other, the sides are smoothed over so that the holes and cracks disappear.

•Openings for doors, and windows are a problem, which can be solved by using temporary vertical planks or shuttering.

•Another very simple shuttering for openings is to use empty kerosene tins.

Adobe

•Blocks shall be kept covered with air tight polythene sheets for first 48 hrs with relative humidity up to 100.

•Polythene sheets shall be removed after 48 hrs and the blocks shall be kept in shaded area like having enough air circulation.

•Sprinkle water over blocks daily, as many times needed, during 28 days.

•Write date of production on block corner.

•Cover stacks top with coconut leaves or any other cover to avoid direct sunlight.

•Principle is that blocks shall not dry for 4weeks.

Suitable Mortar for masonry

•Stabilized Earth Mortar is best suited for masonry using mud blocks.

•Mud mortar shall be stabilized 1.5 times more than the mud blocks.

•Add course sand (0.2 to 2mm) to reduce shrinkage.

•Prepare plastic mix rather than dry mix.

•Ideal mix = soil suitable for mud block + 40% to 50% of sand by weight + 7.5% cement.

Test the mortar before use

•Procedure

- Start with a mix of 1 vol. Cement + 6 vol. Soil + 6 vol. Sand.
- Apply a layer of 1cm mortar on a block soaked in water and let it dray in shade.
- Observe the mortar for cracks.

•Interpretation

- If cracks appear, reduce the soil and increase the sand proportion.
  1 cement + 5 soil + 7 sand.
- If mortar is too crumbly, increase the soil and reduce the sand proportion.
  1 cement + 7 soil + 5 sand

Treatments

Termites

•Mud is the natural home of termites so in areas where they are common the same precautions have to be taken as in all buildings to prevent their moving up into the walls and eating wooden frames etc.

• A one-inch thick layer of mortar (one part of cement to 3-parts of sand) can be laid all over the top of the basement wall before building the mud walls above it. This is helpful in keeping out both termites and damp.

•Even better is to construct an apron of burnt brick or stone (or it can be rammed earth) all round the building (to prevent damage to the walls by splashing, of rain water) and this too can be plastered over with a rich cement mortar.

•Any thin sheet metal may be laid over the basement wall with a 3-inch downward projection before starting to build the superstructure mud wall above. This is expensive but very effective.

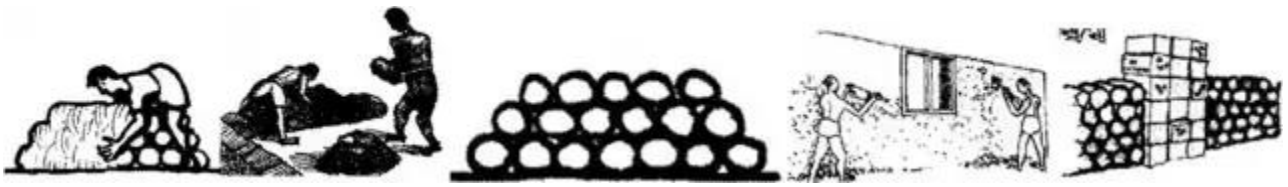
•There are various chemicals on the market, which can be used.

Water

•Water and dampness are one of the major problems for mud as construction material.

•The best way of protecting any wall from either rain or sun is to have a good big overhang to your roof.

•Provide trenches round the house to receive dripping water and drain it away.



7 Steps to build adobe home

7 Steps to build adobe home

Step 1 – Selecting the Ideal Site

Various factors come into play when building an adobe house:

Topography

The land's slope and elevation are crucial factors to consider when choosing the right location for your adobe house. Pay attention to the following:

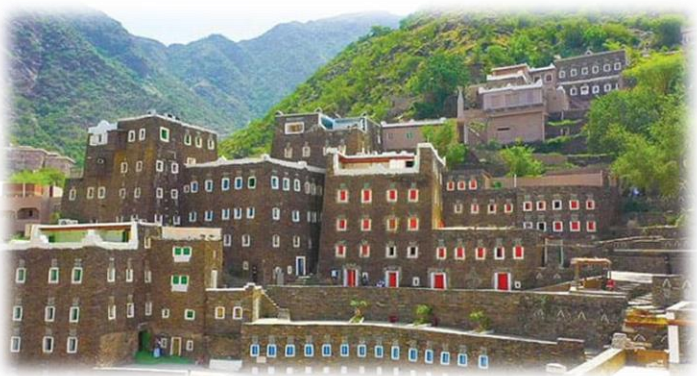
•**Gentle Slope:** Always choose a site with a gentle slope. This allows for proper drainage and prevents water from pooling around the foundation. A gentle grade of about 10% or less is ideal to build on.

•**Elevation:** You need to ensure that the site you're building on is not in a flood-prone or low-lying land area susceptible to flooding.

Soil Type

When building an adobe house, conducting a soil test is crucial to determine the suitability of the soil for adobe construction. Tests like clay content, particle size analysis, moisture content test, and more can tell you the soil conditions you plan to build on.

Your engineer or architect can guide you in the right direction to ensure you build a structurally sound house.



Climate

The location’s climate plays an essential role in the durability and comfort of your adobe house.

Consider these factors:

•**Temperature:** Adobe houses perform best in regions with hot and dry climates. In colder climates, additional insulation may be necessary.

•**Humidity:** High humidity can speed up the deterioration of the structure, so choose a location with low to moderate humidity levels.

Local Building Codes

Complying with local building codes is essential for the safety and legality of your adobe house.

Consider these factors:

•**Permits:** Obtain all necessary permits and approvals before beginning construction.

•**Setbacks:** To maintain a safe distance from property lines and other structures, adhere to local setback requirements.

•**Inspections:** Schedule an inspection by local authorities to ensure compliance with safety standards and building codes.

By following this checklist, you’ll be well on your way to selecting the ideal site. Remember to consult with professionals to ensure the success and safety of your project.

Step 2 – Gathering the Materials Needed for an Adobe House

Below is a comprehensive list of the building materials needed to construct an adobe house:

Adobe Bricks

•Type: Stabilized adobe bricks (made from a mix of clay, sand, straw, and a stabilizer (optional) like cement, lime, or cow dung.
•Quantity: Approximately 4,000 to 8,000 bricks (depending on the house size).

Adobe Mud

•Type: Earthen plaster.
•Quantity: Approx. 6-8 cubic yards.

Window Frames

•Quantity: 8-12 frames (depending on the number and size of windows).

Wooden Beams

•Type: Reclaimed wood or sustainably harvested timber beams.
•Quantity: 20-30 beams (depending on the size and design of the house).

Door Frames

•Type: Wood or metal door frames.
•Type: Wooden window frames.
•Quantity: 2-4 door frames (as needed).

Roof Tiles

•Type: Clay, Concrete, or metal roof tiles.
•Quantity: 10-11 tiles per square meter.

Foundation Materials

•Type: Concrete.
•Quantity: Approximately 30-40 cubic yards.

Insulation Materials

•Type: Fiberglass insulation.
•Quantity: Sufficient amount to cover the target area.

Additional Materials

•Reinforcing bars (rebars) for structural support.
•Concrete Blocks (As needed).
•Rafter, rafter tie beams.
•Wooden lintels.
•Vapor barrier for the foundation.
•Paint & Sealants.
•Electrical wiring, Plumbing materials, and fixtures.

Remember that the quantities are estimates and may vary depending on your house's size, design, and location. Consult a professional architect to determine the exact quantities required for your project.

Step 3 – Preparing the Foundation

Prepare the Ground

The first step to a solid foundation is preparing the ground. This involves:

•**Site Excavation:** Clear and level the construction site, removing vegetation and debris.
•**Soil Compaction:** Compact the soil to create a firm base for the foundation. This prevents settling and ensures the soil can support the weight of the house.

Construct the Footing

An oversized footing is ideal for an adobe house. To construct a footing:

•**Dig Trenches:** Excavate trenches around the perimeter of the house. Follow the dimensions specified in your architectural plans.

•**Install rebars:** Place rebars in the trenches to strengthen the footing.

•**Pour Concrete:** Fill the trenches with concrete, ensuring it is evenly distributed and leveled. Allow it to cure completely before moving to the next step.

Construct a Solid Concrete Stem Wall

A solid concrete stem wall is needed to add durability and helps to distribute the load evenly. To construct a concrete stem wall:

•**Place Concrete Blocks:** Once the concrete in the trenches is cured, place concrete blocks on them. Use mortar to keep all the blocks in place.

•**Install Rebar:** Place rebars inside the blocks to reinforce the stem wall.

•**Pour Concrete:** Fill the hollow blocks with concrete, ensuring it is evenly distributed and leveled. Allow the concrete to cure completely.

Pour the Slab

Pouring a concrete slab involves several critical steps to ensure a good-level surface:

•**Place Gravel:** Add a layer of gravel over the compacted soil.

•**Install Plumbing and Radiant Floor Heating:** Lay out the plumbing and radiant floor heating systems before pouring the slab. Plumbing lines can be installed first, and the latter can be installed after placing the rebars.

•**Install Rebar:** To reinforce the slab, place the rebars in a grid-like pattern.

•**Pour Concrete:** Pour the concrete mix evenly across the

entire area. Ensure you don’t leave any air pockets, and use a screed to level the entire surface.

•**Let it cure:** Allow the slab to cure before proceeding with the house construction.

Note – Vapor barriers and capillary breaks can be added if needed. Check your local building regulations to see whether they are required in your area.

Step 4 – Make Adobe Bricks

Follow these steps to create adobe bricks for your home:

Mixing Adobe Mud

To make adobe bricks, you’ll need:

•Clay

•Sand

•Water

•Straw or some other fibrous material

Steps to Mix Adobe Mud:

1.Prepare the soil: Remove any large pebbles or debris from the soil. Use a soil sieve to ensure a consistent texture.

2.Add straw to water: Take a large trough and mix straw in water.

3.Add Clay and Sand: Introduce clay first, then sand in a 70:30 ratio, and mix thoroughly.

Shaping Adobe Bricks

To shape your bricks, you’ll need the following:

•Wooden forms (measuring 30 x 45 cm).

•Trowel/Putty knife.

Steps to Shape Adobe Bricks

1.Prepare the Forms: Lightly wet the inside of the forms to prevent the finished adobe bricks from sticking to the forms.

2.Fill out the Forms: Scoop the adobe mix into the forms. Press it firmly into the corners and remove any air pockets. Fill the forms to the top.

3.Level the Brick: Use a trowel to level the top, removing excess mixture.

Drying Adobe Bricks

•**Remove the Forms:** Carefully lift the frames after 24 hrs, leaving them on a flat surface to dry.

•**Let the Bricks Dry:** Allow the bricks to air-dry on a flat surface for at least a week. Turn them over occasionally to ensure even drying.

•**Curing the Bricks:** After the initial drying period, stack the bricks with gaps between them and allow them to sit for further curing.

Step 5 – Build the Walls

Framing the Walls

Before laying the bricks, you need to frame your walls. This involves setting up corner posts, door frames, and string lines to ensure straight, even walls.

Corner Posts and Door Frames

1.Measure and Mark: Measure the wall dimensions and mark the locations for corner posts and door frames.

2.Install Posts: Place the corner and door frame posts.

3.Attach Door Frames: Install door frames between the door posts. Make sure they are level and square.

String lines

1.Set up String Lines: Attach the string lines from one corner post to another at the height of each course of bricks. These lines will assist you as you lay the bricks, ensuring straight, level walls.

2.Adjust the Lines: As you complete each row of bricks, move

the lines to the next course's height.

Laying Adobe Bricks

Steps to lay bricks:

1.Start At the Corners: Begin laying bricks at the corner posts, using string lines to guide alignment.

2.Apply Mortar: Spread a thick layer of mortar on each brick.

3.Lay the Brick: Place bricks on the mortar, pressing them firmly into place and removing excess mortar from the joints.

Check Alignment: Use a spirit level to ensure each course of bricks is aligned.

Installing Door and Windows

Once the walls are complete, it's time to install doors and windows. Gringo blocks can be made easily with blocks of wood, and these will help you attach doors and window boxes effectively.

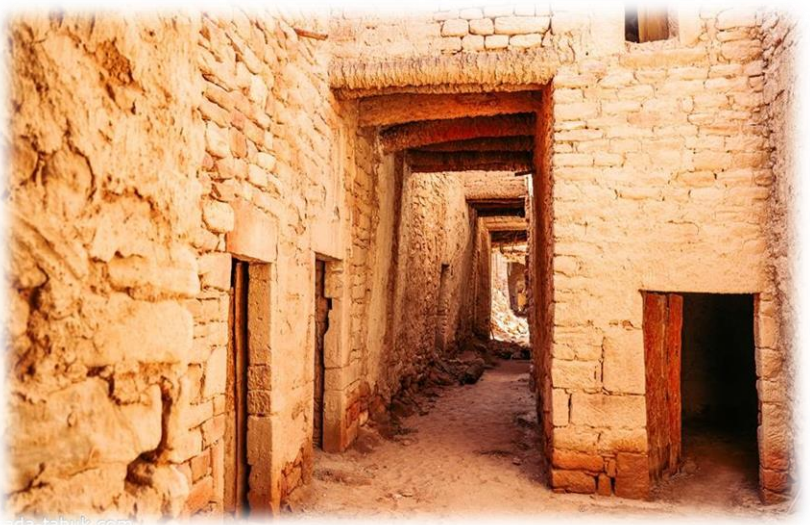
Steps to Install Doors and Windows:

1.Select Gringo Blocks: Choose gringo blocks that match the size and overall shape of your door and window openings.

2.Install the Blocks: Lay the blocks within the wall system where you want to attach the door and window frames.

3.Attach the Frames: Secure door and window boxes to the blocks using screws.

4.Install Doors and Windows: Place doors and windows into their boxes, ensuring a proper fit.



Step 6 – Building the Roof

Flat roofs are a simple and cost-effective solution for adobe houses. They provide an effective and functional solution that complements the traditional design of such homes. I will provide all the steps involved in the making of a flat roof:

Design and Planning

Before constructing the roof, you must determine the right size, layout, and structural support requirements for your flat roof. Consult an architect to ensure your design complies with local building codes and regulations.

Building the Roof Structure

Construct the roof structure using wooden beams, rafters, or joists, depending on your walls' design and load-bearing capacity. These structural elements should be fastened to the walls and adequately spaced. Note that the roof structure will not be completely flat. This ensures that water gets drained and is not collected on the roof.

1.Wooden Beams: Large wooden beams can serve as the primary support structure for the flat roof. They should be placed directly on the top of your walls, spanning the width of the house.

2.Rafters or Joists: Smaller wooden rafters or joists can be installed perpendicular to the beams at regular intervals, about 16-24 inches apart. These will provide the support needed for the next step of roof decking.

Install the Roof Decking

Once the supporting structures are in place, attach plywood or OSB sheets to the rafters to form the roof decking. This decking will also serve as the base layer on which insulation materials will be placed.

Waterproofing and Insulation

Install a waterproof membrane on the top of the roof decking to protect the roof structure and adobe walls from water damage. This layer should cover the entire roof surface and extend slightly over the roof's edges.

Now, apply the insulation materials of your choice. Rigid foam boards or even fiberglass insulation are used in such cases. This insulation step is crucial in maintaining your house's energy efficiency and will help regulate temperature and reduce heat transfer through the roof.

Completing the Roof

OSB sheets can again be used as a roof finish for a more modern and streamlined appearance. OSB sheets are durable, water-resistant, and easily installed on top of the insulation layer.

It is essential to note that the sheet thickness will be 60% of the original size used for the decking. To further protect and improve the sheets, apply a waterproof membrane, coating, or paint them in a suitable color using waterproof paint.

Adobe mud plaster can also be used to give a final finishing touch.

Finally, review the minor details, like incorporating a drainage system such as scuppers or gutters to direct water away.

Step 7 – Finishing Touches

Plastering Adobe Walls

•Select adobe mortar for plastering purposes. This mortar is made the same way you made the bricks but is a bit wetter.

•Before plastering, clean the wall surface to remove any loose material. This ensures proper adhesion of the plaster.

•Monitor humidity and temperature levels during the plastering process. High humidity can slow drying, while extreme heat may cause premature cracking.

•Apply the plaster in thin, even layers to avoid cracking. Use a trowel to level the plaster as you work.

•Allow each layer of plaster to dry completely before applying the next layer. This prevents moisture buildup and ensures a strong bond between layers.

Complete the Floors with Tiles or Polished Concrete

For tiling, there are several options to choose from:

1.Terracotta Tiles

Terracotta offers a warm, earthy appearance that complements adobe walls. They are also durable, low-maintenance, and naturally insulating. You will need a thinset mortar for the installation of such tiles.

2.Saltillo Tiles

These are handmade clay tiles with a rustic charm. Their natural color variations and unique texture make them an excellent choice for adobe homes.

3.Polished Concrete

Polished concrete floors provide a modern, industrial look while offering durability and low maintenance. They can also be colored or painted to match your desired aesthetic.

The thickness of adobe walls varies depending on the design, structural requirements, and insulation needs. But according to the International Building Code, **the minimum thickness should be at least 10 inches.**

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Useful websites

Useful websites

1) https://adelfahmyadobe.com/
2) https://heritage.moc.gov.sa/
3) https://balady.gov.sa/en
4) https://jeddah.gov.sa/
5) https://www.experiencealula.com/
6) https://www.rcu.gov.sa/
7) https://saudipedia.com/
8) https://makanah.org/
9) https://ksaforunesco.org/ar/ksas-world-heritage-list/
10) https://www.bayut.sa/

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The characteristic of vernacular architecture is using the local resources, needs and material to build the house, therefore this kind of house reflect the local traditions, history, culture, environment and climate. Due to the climatic zone, the vernacular architecture will use different bioclimatic features and the benefit to using their features are having air ventilation, thermal comfort and suitable lighting in the building.

In the past, aborigines use limestone as the main material to built their house because limestone can be collected at local quarries in Najd. But in recent decades unfired mud-brick and wooden beams were the main building material used in Najd. The craftsman will apply the mud plaster paste to the wall with a wooden scraper and through wooden scraper moves across the wall to leave the parallel pattern. The bottom of the wall is made up with the four or five cut-limestone. Although unfired mud-brick has dominated Najdi architecture, the pillars of the house and mosques are usually built with stone. Because stone last longer and more resistant to corrosion than mud and wooden beams. The interior wall decoration of buildings for the wealth households is very delicate, the wall covered with geometric figures carved with plaster and flowers pressed with molds.

The decorative motifs that were used on traditional building in Arabia were based on the use of mud reliefs. But across the land of Arabia, using color to painting the house only in Asir region. In order to personalize the residential building, people are encouraged to se the rich natural color pigments and plant colors in their surrounding landscapes in their dwelling units.

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